ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

VOL. XLIII. No. 19.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK..... 297
The Heaviest Passenger Locomotive Ever Built; Delaware, Lackawanna & Western R. R. (illustrated)..... 298
Motor-Controlled and Automatic Signals (illustrated)..... 298
Viaduct Approaches for the New East River Bridge in New York City (with two-page plate and other illustrations)..... 301
Interest on the Failure of the Austin Dam (illustrated)..... 308
Progress of the Metric System in the United States.. 310
The 320-ft. Stone Arch Bridge for the Pennsylvania R. R. at Rockville, Pa. (illustrated)..... 310
New Union Station for the Pennsylvania R. R. at Pittsburg, Pa..... 311
The Accident to the Van Buren St. Lift Bridge, Chicago..... 311
The Reason and a Remedy for the Disappearance of Telescope Cross-Wires..... 312
Book Reviews..... 312
EDITORIAL NOTES..... 304
Large Train Loads and Low Freight Rates on the Lake Shore & Michigan Southern R. R. in 1899.——The Influence of Circulation on the Rate of Evaporation in Water-Tube Boilers.——Progress Toward Adoption of the Metric System in the United States.——The End of the Adirondack Land Survey.——The Passage of the Hepburn Nicaragua Canal Bill.
EDITORIAL:
The Story of the Savannah Harbor Work..... 304
LETTERS TO THE EDITOR.....306, 308
Rusting of Wire Nails.——A Suggested Plan for Preventing the Breaking of Radial Roller Rods in Swing Bridge Turntables (illustrated).——The Elgin Standpipe Failure.——Methods of Interpolating Contour Points (illustrated).——The Extent of the Damage to the Water Power Plant at Hannawa Falls, N. Y.——Diagrams for Determining the Weights of Bridge Spans (illustrated).——The Failure of the Austin Dam.——Notes and Queries.

CIVIL SERVICE EXAMINATIONS for assistant engineers for the New York Rapid Transit Commission will be held on May 14. This examination will be in technical knowledge, experience, mathematics and writing a report, and will be for engineers for grades A, B and C, carrying salaries of $1,200, $1,500 and $1,600, respectively. All who pass this examination will be eligible for appointment to grade A, and will be so notified. A second examination will be held at a later date, at which those who have passed this examination may appear, if they desire, and be examined for either grade B or grade C, but not for both. This examination will be entirely on technical questions. For more detailed information regarding the character and scope of the examination application should be made to F. G. Ireland, Chief Examiner, Municipal Civil Service Commission, New Criminal Court Building, New York city.

THE HIGH MASONRY DAM KNOWN AS THE WACHUSETT dam of the Metropolitan Water-Works will be placed under contract early this summer. This dam is to be built across the Nashua River near the town of Clinton, Mass. It will be founded upon rock, and will require about 225,000 cu. yds. of masonry for its construction. At the level of the crest the distance across the valley is about 1,250 ft., but the total length of the dam, including the waste weir, which is placed at an angle with the dam, will be about 1,400 ft. In the deepest part of the valley the top of the dam will be 140 ft. above the bed of the river and 200 ft. above the rock. At the base the dam will have a thickness of about 175 ft., and at the top of a little more than 20 ft. The depth of earth excavation in the bottom of the valley will be about 60 ft. The works for protecting the excavations from the water in the river have already been constructed to a large extent. It is expected that the granite for the dam will be obtained from an undeveloped quarry now owned by the Metropolitan Water Board, within two miles of the site of the dam. The above information was furnished by Frederic P. Stearns, M. Am. Soc. C. E., Chief Engineer of the Metropolitan Water Board, who states that due notice of the letting will be given in the advertising columns of this journal.

PLATE GIRDERS 107 FT. LONG have recently been erected on the Chicago & Western Indiana R. R., carrying that line across the Chicago & Northwestern Ry. The C. & W. I. R. R. had formerly a long single track trestle on the western city limits of Chicago, but this has now been rebuilt as a double track embankment, with plate girder bridges on concrete abutments, as noted in our issue of Jan. 11. Some of the abutments are faced with 14 ins. of stone, while others are left with the natural concrete facing. The design of the abutments is more pleasing than that of some others which have been built of the same material. They were designed and built by the railway company. The steel bridges were built by the American Bridge Co., of Chicago, who sublet the erection to the Kelly-Atkinson Construction Co., also of Chicago. The large girders, 107 ft. long, are 10 ft. deep over the chord angles, and had to be shipped flat, as they could not be got out of the shops in any other way. They were supported at the middle in such a way as to allow the cars to traverse under them in passing around curves. The centre girder (for double track) weighs 52 tons, and the girders were erected by means of two 60-ton derrick cars, one at each end of the span. Mr. E. H. Lee is Chief Engineer of the C. & W. I. R. R., and Mr. F. K. Vial is Assistant Engineer.

A MEXICAN PACIFIC COAST LINE has recently been located by the Mexican Central Ry., extending from the Continental Divide, near Zapotlan, to Colima and Manzanillo. The latter is a port on the Pacific coast, with a narrow gage line to Colima, 60 miles. The new line is to be standard gage, and will make the descent on a grade of 2%, with 6° curves of 30-meter chords, which are equivalent to 9° curves with 100-ft. chords. There will be 13 tunnels, 12 bridges or trestles and 30 miles of heavy work. The line has been obtained by much hard work and many trials of alternate lines, and is said to be probably the easiest line that will ever be found from the table lands of Mexico to the Pacific coast. For the above particulars we are indebted to Mr. Lewis Kingman, M. Am. Soc. C. E., Chief Engineer of the Mexican Central Ry.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was the derailment of a passenger train while rounding a sharp curve just east of Gastonville, Pa., on the Baltimore & Ohio R. R., on May 4. Investigations made after the accident showed that a spike had been placed on the rail in such a manner as to cause the locomotive to jump the track. The locomotive tender and baggage car left the rails, and one man was killed, another fatally injured and a third painfully bruised and scalded. None of the passengers were hurt.

A LADLE FULL OF MOLTEN IRON was overturned on a trestle at the works of the Illinois Steel Co., Chicago, on May 4. The iron is taken from the blast furnaces to the converting department in cars holding about 10 tons of metal and operated by electricity on an elevated track, beneath which a number of men were working at the time of the accident. The car jumped the track on the trestle, but the foreman shouted to the men beneath and they all got away, though eight of them were badly burned by the flying metal.

AN EMPLOYES' PENSION PLAN is being considered for the Chicago, Milwaukee & St. Paul Ry. system, employing about 24,000 persons. The plan proposed is similar to that in operation on the Pennsylvania and the Baltimore & Ohio railways.

SHAG ROCK, in San Francisco harbor, was blown up on April 30 by 18,000 lbs. of nitro-gelatine, loaded in 34 holes. This obstruction to navigation, containing 3,800 cu. yds. of rock, is now believed to be entirely broken up, ready for removal, says the San Francisco "Call."

THE REORGANIZATION OF THE U. S. NAVAL OBservatory is the purpose of a bill now before Congress, though it is almost too late for action, unless it should be passed as an amendment to the naval appropriation bill. The present movement practically originated in the work of Profs. Pickering, Comstock and Hale, who were appointed a committee to obtain the opinion of American astronomers upon the methods of the observatory. The result was a report to Secretary Long recommending a change in organization. The Secretary then asked these same gentlemen to examine the Naval Observatory, and added Senator Chandler and Representative Dayton to the committee. This last committee has submitted a report to the Secretary, and he approves of the following recommendations: That it is not now feasible to separate the observatory wholly from the navy, but there should be a change in organization and its entire administration should be in the hands of an astronomer. There should also be a civilian corps of astronomers in charge, instead of military officers, and there should be a board of visitors. One of the features condemned was the naval law compelling the retirement of officers at 62 years of age, just when they were at the maturity of their powers as astronomers; civilian appointments would correct this. Senator Lodge advocates the appointment of astronomers to the navy and a retiring pension, just as is now done with civil engineers; he opposes civilian control, fearing that politics will make itself felt in the department.

VARIATIONS IN THE LATITUDE OF NEW YORK city have been observed for the seven years 1893-99 at Columbia University by Prof. J. K. Rees and his associates, Messrs. Jacoby and Davis. The purpose of this work is to trace the oscillation of the earth's axis in relation to the Pole Star. During the seven years 6,518 measurements have been made of pairs of stars; and a diagram for this period has been made showing six general rises and falls, with periods of grand oscillation ranging in length from 12 to 18 months, and from .15 to .40 of a second of arc in extent. The extreme difference between the highest and lowest single observations is .70 second. The variation in latitude of .01 of a second of arc represents an oscillation of the earth's axis of 10 ft. away from or towards the pole of the heavens; and these observations show that while in some years the variation of axis was only 150 ft., in other years it was over 400 ft.

EDUCATION IN COMMERCE occupied the attention of the 132d annual meeting of the New York Chamber of Commerce. This matter has been considered for some time by a special committee, of which Mr. Seth Low is chairman, and this committee has outlined a plan given briefly as follows: It proposes to found a collegiate course in commerce in connection with Columbia University. The course would be adapted to students from 16 to 20 years of age, who on entering shall have a competent knowledge of English, mathematics, history and modern languages. The course, in addition to commercial subjects, would include further progress in English and modern European languages, European and American history, political economy and social sciences. It would also offer opportunity for the study of industrial chemistry and a second or third European language. The course would be four years of 15 hours per day. Under the head of commerce in the four years would be included: Principles and practice of financial and commercial bookkeeping, economical geography, hydrography, meteorology, etc.; history and development of commerce; study of commercial products, sources of raw materials; extension of economic civilization; technique of trade; commercial law; commercial relations of the continent; merchant shipping and trade routes; foreign commercial law; taxation and finance, at home and abroad; statistics and sociology; commercial treaties, etc.

A NEW YORK STATE COMMERCE CONVENTION is to be held at Syracuse, N. Y., on June 6 and 7. The object of this second annual meeting is to consider matters relating to the commerce and manufactures of New York State; and, incidentally, "the laws and usages of business which now make for progress or hinder it." Any state organization for trade or commerce having 20 members may send one delegate, and ten delegates for the first 650 members, and one for each 200 members above 650. All further information may be obtained by addressing Frank S. Gardner, Secretary, 203 Broadway, New York city.

THE EXPORTS OF MANUFACTURES for March, 1900, amounted to $44,767,139. This is the greatest month's export record in our history. The export for March, 1899, was $36,109,231; and for March, 1896, $19,125,725. For the nine months ending March, 1900, the value of exports of manufactures was $313,278,068, as compared with $163,187,935 for the nine months ending March, 1896. This increase is in almost every important line, including scientific instruments, fiber manufactures, chemicals, paraffine, agricultural implements, leather goods, copper and iron and steel. The latter show an increase in the last nine months from $67,212,605 to $86,912,155.

A TRADE SECRET DECISION has recently been handed down by the German courts which is of considerable interest. The foreman of a German factory invented a substance used by his employer in finishing "rustling" velvet. The foreman imparted the composition of this substance to other makers and was sued by his employer and found guilty by the lower court. The defense was that the foreman had only parted with his own invention, which was his intellectual property. The case was appealed to the federal courts and dismissed on the following grounds: The court held that the foreman was employed by the firm and his invention was only a part of the service he owed his employers. Only an employe would be intrusted with the experiments leading to such an invention; and by virtue of the facilities granted, which an outsider would not have, he made his invention, and made it in consequence of his employment, for which he was paid. The court held that in imparting the secret to strangers he violated the German law for "the suppression of base competition."

THE PER CAPITA MONEY CIRCULATION of the United States, says the U. S. Treasury Department, was larger on April 1, 1900, than ever before. For the first time in our history the per capita circulation has crossed the $26 line, and the total money in circulation on that date was $2,021,274,506. On April 1, 1896, this total was $1,528,629,463, showing an increase of $492,645,043 in four years in the total money in circulation. With an estimated population of 77,395,000 the per capita circulation would be $26.12, as compared with $21.53 in 1896. The money in circulation on April 1, 1896, was made up as follows: Gold and gold certificates, $785,845,549; silver and silver certificates and Treasury notes issued in 1890 for the purchase of silver bullion, $631,133,689. In 1896, the gold in circulation amounted to $489,151,505, and the silver, as above, to $558,524,447.

THE HEAVIEST PASSENGER LOCOMOTIVE EVER BUILT DELAWARE, LACKAWANNA & WESTERN R. R.

In our issue of Nov. 9, 1899, we illustrated and described the large ten-wheel locomotive built for fast passenger service on the Lake Shore & Michigan Southern Ry. This notable engine weighed 171,600 lbs. without its tender, and the tender weighed 112,000 lbs. loaded, making a total weight of 283,600 lbs. for the engine and tender complete. At the time this locomotive was described we called attention to the fact that it was the largest and heaviest ten-wheel passenger engine that had ever been constructed, but we hinted also that, in view of the present tendency of American railways to build enormously heavy engines for passenger service, this distinction was likely to be only a temporary one. True to this anticipation we have received from the Brooks Locomotive Works a photograph and a list of the general dimensions of a ten-wheel passenger engine whose weight exceeds materially that of the previous giant among passenger locomotives. This latest engine has a total weight of 179,000 lbs. without the tender, and the tender loaded weighs 120,000 lbs. more, making a combined total weight of 299,000 lbs., or nearly 150 tons for the engine and tender, which is 15,400 lbs. more than the corresponding weights of the Lake Shore & Michigan Southern engine.

To enable a further general comparison of these two huge locomotives we have presented some of the principal dimensions of both in the following table:

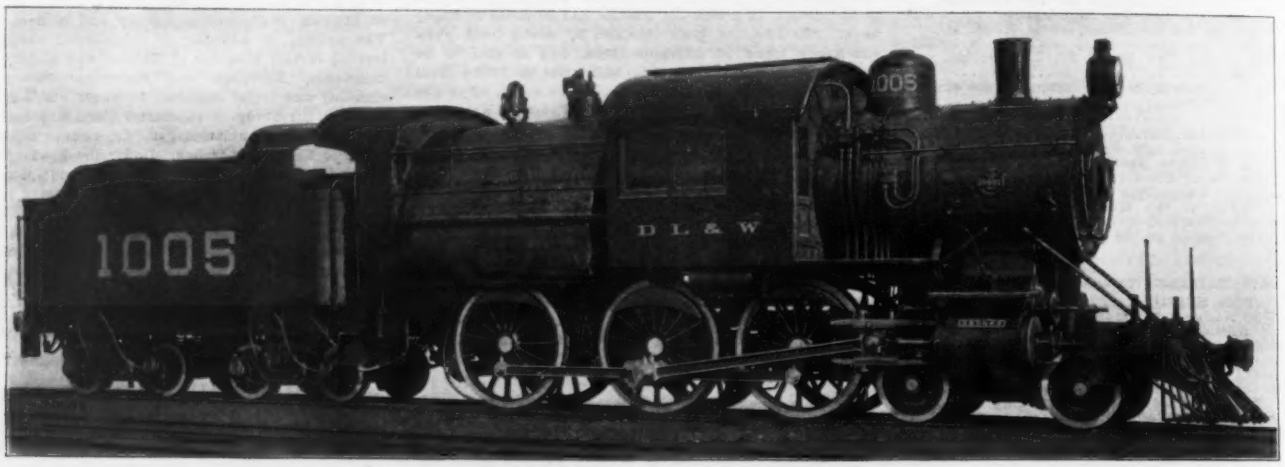
Railway	D., L. & W.	L. S. & M. S.
Builder	Brooks.	Brooks.
Driving wheels, diameter	5 ft. 9⅜ ins.	6 ft. 8 ins.
Wheel base, driving	14 " 0 "	16 " 6 "
Wheel base, total	25 " 3 "	27 " 4 "
Weight on drivers	137,000 lbs.	133,000 lbs.
" total engine	179,000 "	171,600 "
" engine and tender	299,000 "	283,600 "
Compound or simple	Simple.	Simple.
Cylinders	20 × 28 ins.	20 × 28 ins.
Boiler, diameter	6 ft. ⅜ "	5 ft. 6 "
Boiler pressure	210 lbs.	210 lbs.
Fire-box	127 × 97 ins.	121 × 41 ins.
Tubes, number	350	345
" diameter	2 ins.	2 ins.
" length	13 ft. 10½ "	15 ft. ¼ "
Date described in Eng. News.	Present.	Nov. 9, 1899.

It is quite evident from these figures, even without any of the knowledge which we actually have of the differences between the two roads on which they operate, that the two locomotives were designed to work under different conditions.

The general appearance of the new Delaware, Lackawanna & Western R. R. engines is shown by the accompanying half-tone view engraved from a photograph. Altogether seven of these engines have been built for the road. In outside dimensions the engine is 38 ft. ¾-in. over all, and the engine and tender together are 60 ft. 10¾ ins. over all. Referring to separate details it will be noticed first that the steam dome is inclosed by the cab-housing. The valves are of the improved piston type of the builders, and are 10 ins. in diameter. It will be noticed that the boiler is braced both back and forward. The piston-rod is extended through the front end of the cylinder, and has metallic packing. It is 4 ins. in diameter. The main rod is 10 ft. 2 ins. long. The main crank pin is 6¼×6 ins.; the coupling pin is 7×4¾ ins., and the main pin wheel-fit is 7⅝ ins. The driving axle wheel-fit is 9 ins., and the truck axle wheel-fit is 6⅞ ins.

The tender has a length of 21 ft. over bumper beams, and has an under frame of steel channels. It is carried by Brooks 100,000-lb. trucks, with triple elliptic springs. The tender axle boxes are all connected by piping with the water tank. The tender has a housing and roof at its forward end, which telescopes inside the fireman's cab on the engine. The tank is of the horseshoe type, with a length inside of 19 ft. 6 ins., a width of 10 ft., and a height not including the collar of 5 ft.

As previously stated these engines were built at the Brooks Locomotive Works, Dunkirk, N. Y., to whom we are indebted for the matter from which this description has been prepared. The general dimensions and other particulars which have not already been noted are given below in our standard form:



TEN-WHEEL PASSENGER LOCOMOTIVE; DELAWARE, LACKAWANNA & WESTERN R. R.
Brooks Locomotive Works, Builders.

Dimensions of Ten-Wheel Passenger Locomotives: Delaware, Lackawanna & Western R. R.

Running Gear:	
Driving wheels (6)	5 ft. 9⅜ ins.
Truck wheels (4)	3 "
Tender wheels (8)	2 " 9 "
Driving wheel centers	Cast-steel
Journals, driving axles	9 × 12 ins.
Journals, truck axles	6½ × 12 "
Wheel Base:	
Driving, 14 ft.; total engine	25 ft. 3 ins.
Total engine and tender	50 " 10½ "
Weight in Working Order:	
On driving wheels	137,000 lbs.
On truck wheels	42,000 "
Engine, total	179,000 "
Tender, loaded	120,000 "
Cylinders, Number	Two
Diameter and stroke	20 × 28 ins.
Connecting rod, length between centers	10 ft. 2 "
Valves: Type	Piston
Greatest travel	6 ins.
Inside lap, 1-16 ins.; exhaust clearance	1-16 "
Tend in full gear	1-16 ins., neg.
Steam Ports: Length, 20½ ins.; width	2 ins.
Exhaust, least area	75 sq. ins.
Bridge, width	3¼ "
Boiler: Type	Conical connection wagon top.
Barrel, front diameter	6 ft. ⅛ ins.
Barrel, diameter of throat	6 " 5¾ "
Dome, diameter inside	2 " 6 "
Thickness, barrel plates	¾, 13-16, ¾, ⅝ and 9-16 "
Thickness, tube sheet	¾ "
Horizontal seams	Sextuple lap.
Circumferential seams	Triple "
Height from rail to center line	9 ft. 6 ins.
Length of smokebox from flue sheet	5 " 6 "
Spark arresting device	Perforated plate.
Injectors	Hancock composite.
Working steam pressure	210 lbs.
Firebox: Type	Wide, over wheels.
Length, inside, 10 ft. 7 ins.; width, inside	8 ft. 1 in.
Depth at front, 5 ft. 1 in.; depth at back	4 " 2 ins.
Thickness, side plates, ⅝-in.; back plates	⅜-in.
Thickness, crown plates, ⅜-in.; tube sheet	⅝ "
Crown stays	Radial.
Grate, type	Water tube.
Mud ring, width back and sides, 3½ ins.; front	4 ins.
Tubes: Charcoal iron, No.	350
Thickness, No. 12, B. W. G., diameter outside	2 ins.
Length over tube plates	13 ft. 10½ "
Heating Surface and Grate Area:	
Heating surface, tubes	2,520 sq. ft.
" " firebox	180 " "
" " total	2,700 " "
Grate area	84.2 " "
Miscellaneous:	
Exhaust nozzle, single permanent.	
" " diameter	4⅜, 5 and 5¼ ins.
" " distance below center boiler	1 13-16 "
Smokestack, diameter at top, 14¾ ins.; at base	16⅝ "
Height above smokebox	2 ft. 5 "
Height above rail	15 " 1⅛ "
Capacity of tender tank	6,000 galls.
Capacity of coal space	12 tons.
Brakes: American	For drivers.
" Westinghouse	For tender and train service.

MANUAL CONTROLLED AND AUTOMATIC SIGNALS.

By Alexander Holley Rudd.*

In the report of Mr. E. C. Carter, Chief Engineer of the Chicago & Northwestern Ry., to the International Railway Congress, the following occurs:

In conclusion, it may be said that for lines of heavy traffic, with high-speed trains, an ideal system of controlling movement would be: 1st. Interlocking plants at all points where there are switches in the main tracks, the home or advance signals being electrically slotted with a track circuit through the succeeding block. The levers to be supplied with indicators to give information of leading trains in the adjoining blocks. 2d. Automatic block signals placed as required to properly space trains moving between the interlocking plants. Such a system will admit of the heaviest traffic movement, with the greatest safety, with the least detention, and at the least cost for protection.

The two manual controlled systems, in general use in this country, may be briefly described as arrangements of electrical and mechanical devices so applied to interlocking machines actuating block signals, that clear signals cannot be given without the co-operation of signalmen at both ends of the block, together with the actual passage out of this block of at least a part of the train; and so arranged that the failure of any part of the apparatus will prevent the display of a clear signal.

The mechanism of the locking cabinet is so designed that after the operator has moved the plunger which closes the unlocking circuit, and releases the levers of the tower in the rear, he may not again operate it until he has pulled his own signal clear, and restored it to danger. To guard against this being done before the approaching train has passed this signal, a short track circuit is installed adjacent to the latter, the operation of whose relay is also necessary before the plunger is released. A long sleigh driven over a crossing has been known to operate such a relay, and other causes may (though they rarely do) accomplish like results, leaving everything dependent upon one operator.

Several methods are known to experts of "cheating" the machines, and a number of them have been mastered by the ingenuity of operators. None of them will be mentioned here for obvious reasons, although it may be said in passing, without disclosing state secrets, that duplicate keys are a great aid to such performances, which are indulged in usually for the purpose of concealing mistakes on the part of operators, or of saving delays when instruments are out of order.

One dangerous possibility exists: Should a train break in two, and an operator careless, or busy at the wire, fail to note the absence of markers, he may restore his signals to danger after this first part of the train has passed, thus releasing his plunger, and then permit towerman in the rear to admit a following train under clear signals.

This defect was overcome in an installation through the Harlem Line Tunnel in New York in 1892, under the direction of Mr. C. H. Platt (then General Manager of the Terminal), by the use of continuous track circuits, in connection with electric slots on the signals, which restored

*Signal Engineer, D., L. & W. R. R., Hoboken, N. J.; late Signal Engineer, Hartford Division, N. Y., N. H. & H. R. R.

them to danger automatically, on the passage of a train, and kept them out of the operator's control until the entire train had cleared the block. A second "permissive" system was provided for use only when the first for any reason failed, and was an exact duplicate of it except that track instruments were substituted for the track circuits, which local conditions rendered difficult of maintenance. While an ideal system for this place, fulfilling all requirements as nothing else could do, the majority of roads would justly regard it as too expensive for general use. It, however, covered the feature of parted trains completely, caused a revolution in the methods and modes of construction of the existing block systems, and so constituted a great step in advance.

There are other disadvantages inherent in the manual controlled systems, few and small it is true, but still disadvantages, which should be mentioned in a fair consideration of the subject.

At an interlocking tower it may be necessary to back a train in on a siding to clear for a train of superior class following. Under one of the controlled systems, if by any chance this entire train passes the cleared advance signal before backing in, this signal must, of course, be restored to danger before the fast train can be admitted to the block in the rear, and a second unlock for it cannot be had, because as far as the automatic devices are concerned, the first train has entered and has not left, at the far end, the block they protect. With the other system this trouble occurs if the advance signal has been unlocked, and any part of the first train passes it. Therefore the fast train must be stopped and given a clearance card. On some roads, to avoid this delay, hand signals are given at such times; but this practice is a reprehensible one, as misunderstandings may occur, and if any trouble results the stories of the engineer and operator may conflict. The former should receive a card order to proceed, for his own protection.

In one of the systems mentioned a slide in the instrument to be unlocked is kept normally in such a position that the unlocking circuit remains open. A misplunge at the unlocking end may be rectified, and subsequent "plunges" made until an unlock is had, if the slide is in the position noted. If, however, it is in the second or unlocking position, and a misplunge is made; or if after an unlock the slide is allowed to slip back, a failure results, and the approaching train is of necessity stopped. With the other system a poor plunge cannot be rectified, and if an unlock is given in error the instrument remains free, which in certain eventualities might result seriously.

The first-mentioned system requires two wires besides the bell or telegraph line between towers, the action of lightning and foreign currents being provided against in the slide already referred to. The second system requires three wires besides the bell circuit, and these should be insulated to protect from foreign crosses which, if the common wire should chance to be grounded, might unlock erroneously.

In the first system open circuit batteries can be used for the unlocking circuit, and the usual gravity battery for electric locks and track circuits; with the other, gravity battery is used throughout. In either case less battery is required than with the automatic system.

The maintenance cost of the automatic and manual controlled is probably about the same, but the expense of operation of the latter far exceeds the former, and for this reason blocks are frequently longer than the prompt handling of traffic requires. Let us suppose, for instance, the establishment of a controlled block system in the open country, on a line having few switches, with a tower every two miles, obviously the capacity of a 50-mile road is limited to a maximum of 25 trains each way, attained only when all travel at the same rate. With varying speeds, delays to one and another will be continuous. If an automatic system of like arrangement has been established, the capacity may be doubled, by making the blocks a mile long at a general cost of $200 per signal if overlaps are used, or $400 per block if employing distant signals, or a total of $800 per double track block.

Manual controlled simple block towers would cost at least $1,000 each to erect, and the maintenance would be practically the same as with the automatic system, but the operation would require at least two men during the twenty-four hours, whose wages at a minimum of $30 per month would total $7,200 per year for each tower added.

If one of these block operators is disabled or takes his rest while on duty (and on cold winter nights when the fire is hot, the lights dim and low, and trains few and far between, such trips to the land of nod have been made), delays at least are caused, if nothing worse. The writer remembers the case of a train waiting five minutes at a signal, when the conductor entered the tower to investigate, tearing the operator from the arms of Morpheus, with a yell of "What in —— is the matter here?" and receiving the sudden and startling reply, "There's a horse in the block." Obviously the operator had the nightmare.

Under such circumstances one stop is necessitated, and delay ensues until the operator can get back to earth and act intelligently. If, however, the operator deliberately prepares for his journey, he will get an unlock from the man on each side of him, and clear his signals before he "wraps the drapery of his couch about him, and lies down to pleasant dreams," in which case the train must stop for a caution card at the rear tower, and proceed under control to the "sleeping beauty," and to be on the safe side it should not proceed on finding signals clear, but the conductor should personally ascertain the cause of the failure, and be certain that the block ahead is clear. This means a considerable delay with two stops—and such cases are not unusual.

Now on the other hand the advantages of the manual controlled system, if properly installed, are manifold. Trains are absolutely spaced, enginemen cannot run signals without detection, and "permissive blocking" is only allowed when the apparatus is seriously out of order. If the locks fail, the bell code remains. If this latter also gives out, the telegraph is usually still available, although in some places it is the practice to save wages, by employing operators at interlocking towers only, relying on the bells at other points.

If trains are disabled or wrecked, aid may quickly be summoned and trains on parallel tracks stopped and protected. Any dangerous defects in the condition of passing trains may be noted, and reported to the tower in advance, and in this manner a system of patrols is established which cannot obtain under the purely automatic system.

The most complete arrangements provide towers at each main line crossover, while minor spurs and sidings are electrically locked, and placed in this way under control of the nearest towerman, who can accomplish their release only after he has set and locked his signals at danger.

Automatic signals have reached such a stage of perfection that at present a false clear indication occurs not oftener than once in 900,000 or 1,000,000 signal movements, and on the other hand one train is stopped in every 5,000 to 6,000 movements. The average percentage of failures on the Hartford Division of the N. Y., N. H. & H. R. R. has been 1.15 per signal per year for the past three years, and 1.25 per signal per year for the past four years. So that their reliability can no longer be questioned, and they are ideal signals for block working where lines are free from switches.

The protection of these latter is, however, incomplete. At each one an indicator is installed showing the position of the protecting signal. If a visual indicator is provided, trainmen may fail to notice it, and it is easily broken by trespassers. If a bell is used, it may fail to ring through some breakage or poor adjustment, and a train ready to come out of a siding, for instance, has no warning of the other train, which may have already passed this protecting signal at clear.

The indicators serve two purposes, showing either train in block, or that signal has taken danger position in response to the switch movement.

In some late installations the latter feature is omitted, and indicators are arranged to operate when a train approaches within a thousand feet or so of the protecting signal. This leads to complication of circuits, and is done solely to cover a chance which might be presented once in a lifetime; namely, that of an engine passing the signal at the very instant when a switch is opened, and the engineer and switchman each thinking that his own act causes its operation.

Some managements favor the idea of setting the signals before the engine reaches them, so that the engineer may see them operate. Allowing sufficient distance for high speed trains may mislead slow ones; in any case this practice prevents the possibility of stopping a train at the last moment in emergencies, and forces the constant passing of signals at danger, which is a bad habit for engineers to acquire, and is unnecessary where reliable signals are used.

It is claimed that enginemen may disregard automatic signals without check, as no towerman is near to report them. It has been our experience that a very little discipline of the proper sort prevents this entirely, and on general grounds a man will not rush into danger unnecessarily. While the rule of waiting a prescribed time may not always be adhered to, still a stop is made, and caution exercised until the block is passed. Permissive signaling is practiced, as a train is allowed under the rules to proceed after waiting this time interval, and engineers receive no information as to the cause of the danger indication, in both of which features the manual controlled system is superior. On the other hand, if a train is disabled, aid may reach it under the automatic system more quickly than if the following train is held at a tower until the flagman gets back to it.

Among the advantages of the automatic system it may be noted that a portion of a train left in a block is fully protected; cars on sidings fouling the main line for any cause, and broken rails, cause the danger indication; and delays due to the lapses of operators are unknown.

Now let us see what advantages may be gained by combining some of the features of the two systems.

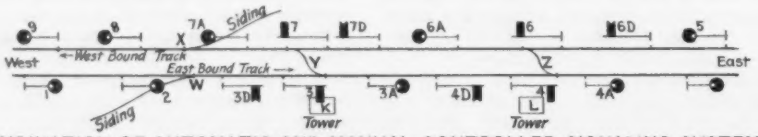
After an automatic block system has been installed, it is often found necessary to provide interlocking at important points. It is the common practice to leave the block system as originally installed, and make the interlocking signals entirely separate and additional (virtually switch signals within the block), and unnecessary delays occur through trains being held at block signals, perhaps half a mile or more, away, while the junction is being used by others. This condition led to a careful study of the subject, and the installation of a plant in 1895 under the writer's supervision to overcome these and other difficulties.

Others working along similar lines had attained somewhat like results, at that time unknown to me, so that it cannot be claimed that the scheme is entirely a novel one; but it contains some new features which may interest the reader. Devices already in use for distinctly different purposes were employed, the circuits being a combination of well-known principles formerly applied to accomplish other ends. The results, which are noted below, were so satisfactory that the system was further extended, and has now been given a successful trial under varying local conditions, at isolated towers with automatic block signals on either side; and between towers, the automatic signals taking the place of the slotted advance signals suggested in Mr. Carter's report, hereinbefore quoted. These cases cover all conditions to be met. In the accompanying diagram, automatic distant signals and overlap sections have been omitted for simplicity of description, though one or the other would of course be used.

Should tower K be a distributing point for eastbound trains, with facing switches, etc., these trains would be announced and described from the next station or tower west. Take the example of a train proceeding on the eastbound track. Signal No. 1 is set by passage of train, and clears when rear passes No. 2. No. 2 is set by entrance of train into block, and an indicator is dropped in tower K, at which point are also located hand switches, normally closed, and in circuit with signals 2 and 3A, by means of which these latter may be set at danger when necessary, both, however, being normally clear, although the normal

danger principle is entirely applicable. When indicator No. 2 drops, operator clears signal No. 3, and 3D, unless 3A is at danger, in which case 3D is electrically locked at caution.

When train passes No. 3 signal, No. 2 does not clear from the track circuit automatically, but lever No. 3 must be put home (setting signal No. 3 at danger), and lever latch 3 also put normal. Before this latter is quite down, it is locked by an electric lock operated from a track circuit between signals 3 and 3A, and cannot be pulled again until the rear of the train has passed 3A, when 3 may again be cleared, but 3D is held at caution until the train has passed signal 4 (operated in the same manner as 3 just noted). The placing



A COMBINATION OF AUTOMATIC AND MANUAL-CONTROLLED SIGNALING SYSTEMS.

of 4 to danger clears 3A, which in turn releases 3D for a second train.

Suppose the train, after passing signal 2, takes siding W, instead of running through. If W is electrically locked from the tower, the trainman uses the bell code, and the operator, in order to release the switch, must put signal 3 to danger and operate the hand switch referred to, which opens circuit 2 and then unlocks switch W. As soon as the train has cleared fouling point, and switch W is closed, the tower switch is again thrown, signal 2 is cleared, and switch W is locked. Operator may then clear signal 3 for next train, and also 3D if 3A is clear. If switch W is not electrically locked, then the conductor of a train taking the siding will announce the move on bell in tower. The operator will then place signal 3 at danger, and signal 2 will clear as soon as the train is clear of the main track. When the indicator shows this to operator, he may clear 3 for the next train.

Trains coming out of siding will receive permission by bell from operator before leaving, and the act of throwing the switch W will set signal 2.

The same methods of procedure would be followed in case of siding X, protected by advance signal 7A, except that the movement of the semaphore lever 7 would be unnecessary. Should signal 3 be cleared before train passes signal 2, the latter signal would not be set at danger until train passes it; but after it has been so set, 3 must be put to danger and locked there (if train runs through), and the entire train must be off circuit 2 before the latter will clear again.

Now to what degree are the strong and weak points, inherent to the two general systems in question, embodied in the above described combination?

1. Parted trains are fully protected.

2. Unlocking of instruments is impossible, as the automatic devices are beyond control of the operators, or if within reach, any tampering will result in the signals indicating danger.

Home signal locks may be withdrawn mechanically, but not electrically, if local conditions make this imperative for conducting switching, etc., or they may be so arranged as to make this impossible.

3. By cutting the track circuits at distant signals, check locks may be so applied that after a train has passed a distant, with the home at clear, the latter may be put to danger, but the route cannot be released until the train has entirely passed it. Special releasing buttons may be supplied to cut these locks out if it is necessary to change the route, which, however, can be done only after the operator's attention has been directed to any attempted error.

4. The delay noted above incident to running by advance signals, and then backing into siding, is eliminated, while at the same time the advance is automatic in its action, having all the advantages of an electric slot, combined with simplicity of design, and less liability of failure. Even should such a failure occur, distant signal cannot be cleared with advance at danger, as in the case of slot failures (except in the rarest instance when a failure occurs after the distant has been cleared, and even in this case the indicator reveals the condition, and a watchful operator will set his distant before a train reaches it).

5. Nearly all the devices are simpler in design than those of the purely manual controlled systems, and the remainder are not more complicated. The same number of wires is required as in one of them, namely, two, besides the common and bell wire, where towers are adjacent; but with auxiliary blocks these wires are not continuous, the intermediate blocks requiring none. For instance, none would be required between 1 and 2, or between 7A and 9 (except for the bell between X and tower K).

When through wires are employed only one need be insulated, any crosses, except between the two main wires, resulting in the danger indication, and even if these mains should by any possibility get together, the advance signal would set automatically, and would clear when entire train passed the home signal at the next tower, but without forcing the operator there to put the latter to danger. Still his indicator would call his attention to the fault at once, and such troubles are quickly located.

6. Sleighs, and operators placing wire across the rails, will not unlock, but will set signals and during the period of the cross only. Lightning, if it has any effect at all, will tend to clear the signal only during the passage of the flash, or else set it permanently at danger, by fusing connections.

7. All chances of operators misplunging, or plunging in error, letting slides slip, etc., are entirely eliminated, because these devices are not employed, the levers doing this work.

8. Delays caused by trains taking sidings or being disabled, are reduced to a minimum, as in the automatic system; while, at the same time, the switches are protected as well as by the manual controlled system, with the further added safeguards of indicators located at them.

9. If automatics are out of order, operators will at once notice them in a majority of cases, and frequently repairs can be made before a train arrives; while at the same time a check is had on engineers running past signals, except when there are three blocks between towers, for the tower indicators will show the condition of signals on each side when the train passes them.

10. The watching of trains for dangerous features is fairly well covered, the better, of course, where towers are frequent.

11. No more battery is required than for operating the simple automatic system.

12. The danger of operators sleeping with signals clear is reduced to a minimum, for the train is stopped at the last automatic before reaching the tower, and (the advance also working automatically), the space between home and advance is the only part left unprotected, while the chances are overwhelmingly against an operator sleeping if this short block directly in front of his tower is occupied by a train.

13. Additional blocks may be installed on the automatic system with no cost except for the batteries, relays and signals themselves.

14. Dictinctive signals are provided for all indications. A semaphore distant; a semaphore home (of different design, and with a distinctive light) and a "banjo," or an electric semaphore (which varies from the standard manual controlled semaphore), for a block signal. The first, if set, means "caution," the second, "stop," until cleared or a clearance card is given; and the third usually "wait a prescribed interval and then proceed cautiously unless clear indication is displayed."

A point raised against "banjo" signals is indistinctness of indication under certain conditions. As the semaphores distant is the key to the situation, and gives warning if the automatic is set, this difficulty is obviated.

The millennium of signaling will come, when such perfection is attained that a false clear indication will be unknown; failures of other kinds will be so rare that time lost in station stops, defects of motive power, heavy trains, etc., cannot safely be attributed to "delayed by signals"; and reports

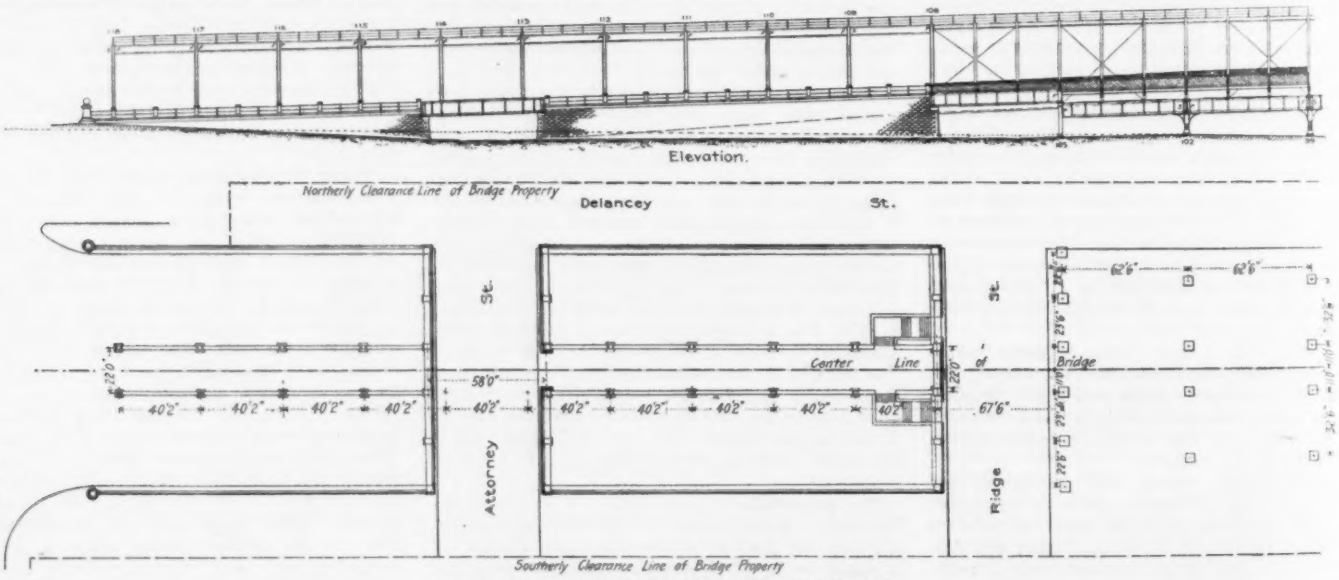


FIG. 1.—MASONRY TERMINAL OF APPROACH.

of "signals out of order," when received, will not be sent to repairman until a glance is had at the train sheet, to determine what was ahead—a decided variation from present practice.

VIADUCT APPROACHES FOR THE NEW EAST RIVER BRIDGE AT NEW YORK CITY.*

(With two-page plate.)

We illustrate in the accompanying cuts and on our [illegible] page plate, this week, some of the typical structural details of the viaduct approaches for the New East River Bridge, now under construction at New York city. There will, of course, be two approaches, one to each end of the bridge structure proper, which terminates at the anchorages on either side of the river. The New York approach will be much the longer of the two, and will contain in round numbers 12,000 tons of steelwork. There will be only 6,000 tons of steelwork in the Brooklyn approach. Bids for supplying and erecting this steelwork, and the masonry substructure which goes with it, will be received by the engineers until May 31, 1900, and our illustrations are reproduced direct from the printed plans and specifications which have been issued to prospective bidders. These illustrations, with the abstracts of the specifications, which are given further on, will show the details of the approach structure. Its general character may be described briefly as follows:

At the inshore end each approach will be made by building enclosing walls of masonry, together with stairways, etc., and filling the space between the walls with selected earth carefully rammed, on which the roadway material, paving, etc., can be laid. This masonry portion of the approach is shown for the New York end of the bridge by the general plan and elevation, Fig. 1. From the river end of the masonry, acting as an abutment, the approach continues as a steel viaduct to the anchorage. Across the top of the anchorage a special construction will be employed to support the roadways and tracks. The plan and elevation, Fig. 2, show the anchorage end of the approach, and a section of the steel viaduct work. The sectional elevations, Figs. 3, 4 and 5, which are taken transversely of the approach at the points designated, show the relative arrangement of the various roadways, sidewalks and railway tracks. At the beginning of the approach the footwalk is in the center, the bicycle path over it and the elevated railway tracks over the bicycle path. On either side of this three-story thoroughfare there is a double trolley car track, and outside of these tracks a roadway for horse vehicles. The roadways and trolley car tracks hold the same relative positions the entire length of the approach, but as they approach the anchorages the bicycle paths and footways gradually rise until at the anchorage they have become the same and are nearly at the level of the elevated railway track.

It will be seen from the preceding general description that the approach structures consist of a number of distinct parts, which may be defined roughly as follows: (1) The masonry terminals; (2) the viaduct structure proper; (3) the roadway and track framework surmounting the viaduct structure; and, (4) the anchorage framework. The distinction between these several parts is not sharply drawn in a number of details, but it is clear enough in a general way to permit of its being used without much error in describing the structural work of the approaches, and the divisions adopted will be employed in the following description. This description, it may be stated here also, refers particularly to the New York approach, but it will serve equally as well in all important features for the Brooklyn approach.

Masonry Terminals.

The general construction of the masonry terminals is quite clearly shown by Fig. 1. Beginning at the street level at Clinton St., two retaining walls, parallel to the axis of the bridge, 111 ft. 6 ins. apart c. to c., and increasing gradually in height to conform to the ascending grade, extend to the west side of Attorney St., where their ends are connected by a transverse retaining wall. An elevation of this end wall is shown by the upper drawing of Fig. 3. Midway between the side walls are placed two rows of column foundations at a distance of 11 ft. each side of the bridge axis, or 22 ft. apart. These foundations consist of three concrete blocks of decreasing lateral dimensions upward surmounted by a granite masonry block and a granite capstone carrying a cast column base. The foundation rests on piles, driven with a 4,000-lb. hammer until the penetration under a 15-ft. blow does not exceed 2 ins. Between the foundations of each row there is a curb wall running parallel with the bridge axis. From the foundations rise the two rows of columns carrying the elevated railway tracks, and between the parallel curb walls is the bicycle track. Adjacent to the bicycle track on each side come two lines of trolley car tracks, and outside of these and separated from them by a double curb wall come the two roadways. The half transvere section, Fig. 6, shows the details of the bicycle track and roadway arrangement just described, except the elevated railway structure, which is indicated by Fig. 3.

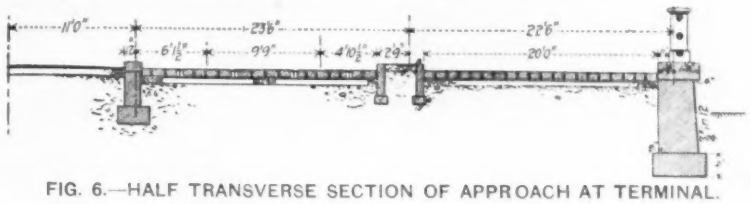


FIG. 6.—HALF TRANSVERSE SECTION OF APPROACH AT TERMINAL.

The several thoroughfares mentioned are continued across Attorney St. on a plate girder structure consisting of six parallel 58-ft. plate girders spaced 22 ft. 6 ins. apart for the roadways, 23 ft. 6 ins. apart for the trolley tracks, and 22 ft. apart for the bicycle path at the center. The columns for the elevated railway structure are carried directly on the top chords of the two center girders. The floor system consists of trough sections of the form shown by Fig. 7.

Across Attorney St. the masonry structure begins again and continues to the west side of Ridge St. Except that this masonry contains a longitudinal interior subway under the bicycle path for a footwalk, it resembles closely that of the preceding section described above. It will be noticed that this footwalk subway begins at grade at Attorney St., Fig. 3, and gradually rises as it approaches Ridge St., from which it has double stairway connections. The walls and ceiling of the footway and of the stairways leading to it are to be lined with white enameled brick, and the walk itself and the stairway landings are to be of asphalt. Fig. 4 shows clearly the relative arrangement of the roadways, walks, bicycle path, and railway tracks at the west side of Ridge St. Ridge St. is crossed by six parallel plate girders seating on the masonry at one end and on a trestle bent of steel columns at the other end. In this span the floor framing of the roadways consists of buckle plates carried by beams and stringers, and that of the footwalks is of trough sections.

The character of the masonry for the masonry

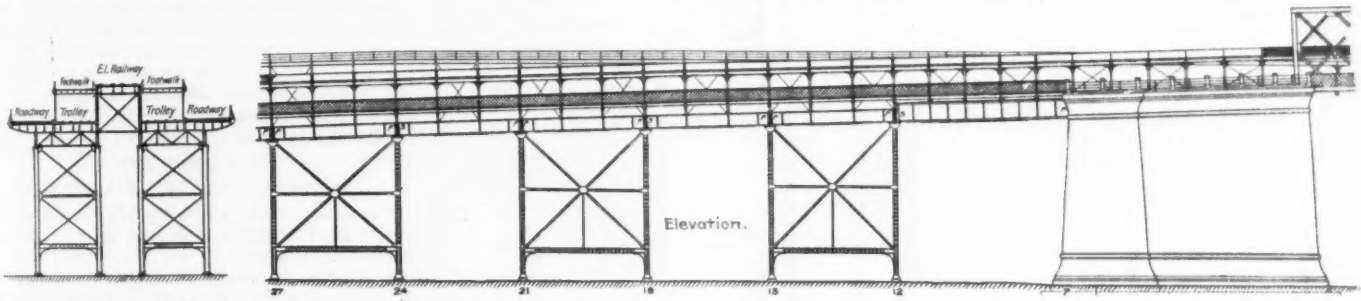


Fig. 5.—Transverse Section of Approach Near Anchorage.

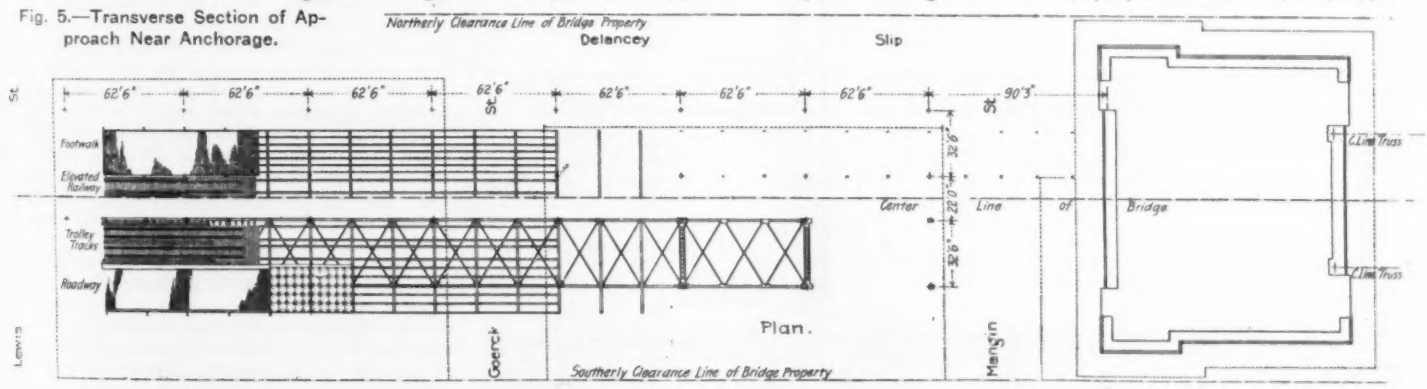


FIG. 2.—PORTION OF APPROACH NEAR THE ANCHORAGE.

*Previous articles relating to the New East River Bridge have appeared in Engineering News, 1896, Vol. II., p. 198; 1897, Vol. II., pp. 173, 331; 1898, Vol. I., pp. 114, 144; Vol. II., p. 66; 1899, Vol. I., pp. 136, 143; Vol. II., pp. 330, 352.

terminals is to be first-class rock-face coursed masonry of high quality granite. Its general character and the character of the foundations and of the column pedestals are given in the following abstract from the specifications:

Excavation.—The foundations for the masonry will be prepared by first making excavations, somewhat larger than the full size of the masonry to be placed in them. The foundations will sometimes be located in old cellars or in made ground; the excavations for the foundations shall always be carried at least 6 ins. into the natural soil, wherever practicable, and the space between the level of the bottom of the foundation and the base of the standard masonry shall be built of concrete. In soft ground piles will be driven, on which the concrete foundations will be built. The excavations must be sheeted and braced sufficiently to prevent the sides from caving in.

Piling.—Piles will be driven, with a 4,000-lb. hammer, until the penetration from a blow of the hammer falling 15 ft. does not exceed 2 ins. When this point is reached, five more such blows shall be struck, to ascertain whether the pile has reached proper bottom. All piles must be banded sufficiently to prevent splitting, and, whenever necessary, must be shod to the satisfaction of the Engineer.

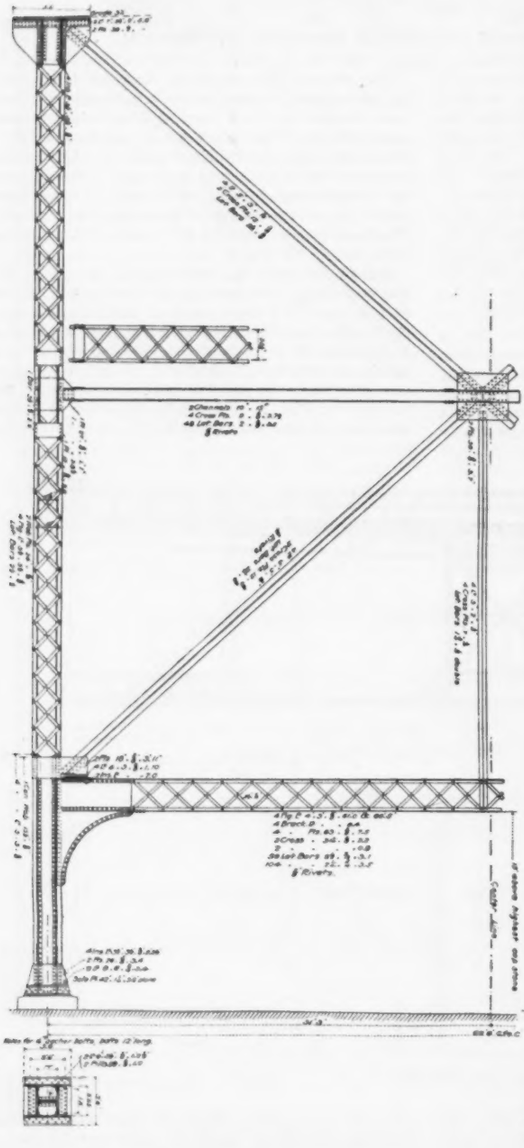


FIG. 8.—HALF SIDE ELEVATION OF VIADUCT TOWER.

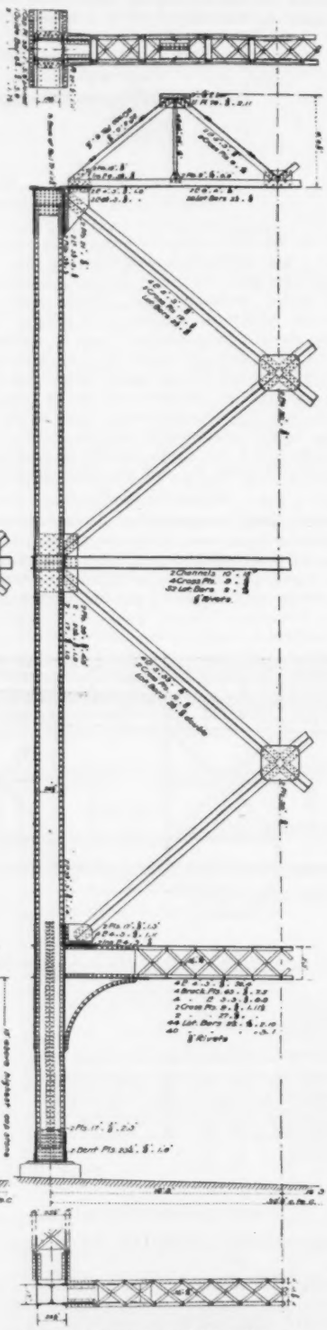


Fig. 9.—Quarter End Elevation of Viaduct Tower.

Cutting off and Concreting.—After the piles are driven, their heads will be cut off on a level 1 ft. above the bottom of the excavation. The space between and around the exposed portions of the piles will then be filled solidly with Portland cement concrete to the level of the tops of the piles, and the balance of the concrete foundation will be built and brought up to the level of the stone masonry, as shown on the plans. The concrete must be rammed sufficiently to insure the flushing of all voids with mortar.

Masonry.—On the concrete will be built the regular masonry of granite dimension stones. Except the coping, water tables, etc., it will be rock-faced, with joints pitched to the lines shown on the drawings. The upper and the lower beds and the vertical sides will be rough pointed, with parallel beds, vertical joints square to the beds and to each other, and true to straight edge in every direction. The bed and the vertical joints will be ½-in. throughout except for six-cut work.

Face Stones.—The rock face shall be uniform in appearance, and must not project more than 3 ins. beyond the pitch lines; it must average at least 1½ ins. beyond the pitch lines, and have no depression extending back of them. The water tables, quoins, arch-stones, coping, bridge-seats and all ornamental work shall be six-cut work on all exposed surfaces; the beds shall be rough pointed and this masonry shall be laid with ¼-in. joints for at least 1½ ins. inward from the face.

Coping.—Each pedestal will be surmounted by a coping of one stone, having its bed rough pointed. Its upper surface and edges will be of six-cut work.

Stone Setting.—All stones must be carefully cleaned and wet before being laid, and stones already laid must be cleaned and moistened to receive the mortar bed for each stone to be laid on them. All stones must be laid on their natural beds, and thoroughly bedded in full flush beds of mortar freshly mixed. The vertical joints must be thoroughly flushed with similar mortar. No grab holes shall be made in the six-cut work.

Brick Masonry.—For the ordinary brickwork the bricks shall be of the best quality, burned hard entirely through, regular and uniform in size, and of compact and uniform texture. For enamelled brick facing the bricks must be of the best quality, uniform in size and texture, and the enamelled surfaces must be free from cracks or crackle and of uniform hardness and color. [illegible] brick masonry must be laid in Portland cement mo[illegible]. The bricks must be thoroughly wet just before lay[illegible] brick shall be completely imbedded in mort[illegible] care being taken to have the joints full, and [illegible] shall be neatly pointed. The enamelled brick [illegible] laid and pointed with specially prepared mo[illegible] to ensure a perfectly uniform surface, both as [illegible] and color.

Pointing for Stone Masonry.—All face joints [illegible] cleaned out to a depth of 1½ ins., and pointe[illegible] weather with mortar made of equal parts, by m[illegible] Portland cement and sand, which shall be driv[illegible] with a calking iron. The surface of the joint [illegible] be rubbed smooth and true with a rounded t[illegible]

Mortar.—For all concrete and masonry, th[illegible] except that for pointing, shall be made of Po[illegible] ment and sand in the proportion of 375 lbs. [illegible] to 8½ cu. ft. of sand. The cement and sand [illegible] thoroughly mixed dry. Clean, fresh water wi[illegible] added, but only in quantity sufficient to give t[illegible] consistency to the mortar when the mixing is [illegible] Mortar left over till it has partially set shall no[illegible] on the work.

Concrete.—Concrete shall be used for the found[illegible] the footing courses of all masonry, but must no[illegible] ried up higher than an elevation 2 ft. below [illegible] elevation of the lowest ground adjacent to it; and when ever concrete is used under masonry, it must project at least 6 ins. outside of the neat lines of the masonry. All concrete shall have sufficient mortar to insure its filling flush all voids or interstices between the stones, and the proportion of stone to mortar shall in no case exceed six parts to three by measure. The broken stone, washed clean, shall be added to the mortar while wet, and the mass shall be thoroughly mixed by machine before being put into place. The concrete shall be deposited in even layers of not more than 12 ins. in thickness. It shall be well rammed till the mortar flushes to the surface. Each layer must be cleaned and moistened before the next is laid.

Anchor Bolts.—Each column of the viaduct will be secured to its foundation by four steel anchor bolts. All column bases and beds plates, resting on masonry, shall be bedded on rust joints satisfactory to the Engineer.

Viaduct Structure.

The plate girder bridge across Ridge St., brings the approach to the first span of the viaduct structure proper. Briefly described, this consists of braced columns resting on masonry pedestals, and carrying plate girder spans each 62½ ft. long. The general character and appearance of this structure is shown by the plan and elevation of Figs. 2 and 5. Figs. 8 and 9 show the details of the tower construction separate from the girder spans which the towers support. The drawings of Figs. 8 and 9 are for one of the taller towers near the anchorage. The general details of one of the shorter towers are shown by Figs. 10 and 11, and also by several of the other illustrations. The details of the plate girders which are carried by these towers are shown more particularly by Fig. 12. For the foundation construction and character of the steelwork the reader is referred to the preceding abstract from the specifications.

Roadway and Track Framework.

The roadway and track framework surmounting the viaduct columns is shown by Figs. 10 to 19, inclusive. In a general way Fig 10 will serve as a key drawing by which to locate the various parts of the framework. The first of these parts to be noted is the floor framing for the trolley lines and the roadways. This floor framing consists essentially of transverse plate-girder floor beams resting on the top chords of the girder spans, and carrying stringers which serve to support the flooring and track systems proper. Details of these floor beams, stringers, etc., are shown by the drawings comprised in Fig. 13. It will be noted that the roadway floor framing will carry a bucket plate flooring upon which will rest the roadway paving.

Referring to Fig. 10 again, it will be observed that the two inner lines of plate girders carry two rows of columns which support at their tops and between themselves the floor framing for the elevated railway, the bicycle path and the footwalks. Respecting the relative location of the footwalk and bicycle path it will be noticed that it is the same as it was at the beginning of the steelwork at Ridge St., Fig. 4. By referring to Fig. 5, which is a transverse section of the viaduct approach near the anchorage, it will be seen that the footwalks have become two in number instead of one, and that they are nearly at the level of the elevated railway tracks. The apparent disappearance of the bicycle path is due to the fact that it and the footwalks have become the same thoroughfare.

To explain the manner in which the change just noted occurs the reader is referred to the part transverse section at bent No. 60, Fig. 14. It will be noticed that the three-story arrangement of the footwalk, bicycle path and elevated railway tracks still exists. At the next bent No. 59, Fig. 15, however, a change has taken place in the bicycle path,

and at the following bent No. 58, Fig. 16, the single bicycle path has been divided into two paths located directly over the trolley tracks. From this point the footwalk rises gradually between the two bicycle paths until it reaches the same level where it is merged with them as shown by Fig. 5. For more detail, by Figs. 17, 18 and 19, which show sections and a plan at bents Nos. 24 and 25. From this point on the elevated railway tracks and the two footwalks continue to meet over the anchorage in the relative positions shown by Fig. 5. The details of the floor systems for these three locations are also shown by Figs. 17 to 19, inclusive.

Anchorage Framework.

In order to carry the various track and floor systems over the anchorage it is necessary to bridge over the recesses in the masonry between the outside walls. This covering will consist of plate girders carried by the side walls and by interior columns and supporting floor beams between which are sprung brick arches covered with concrete and an asphalt paving. The section, Fig. 20, indicates the character of this floor construction quite clearly.

From the drawings and the following abstract of the specifications for the steelwork a fairly good idea of its character may be obtained:

Steel.—All steel shall be made in an open-hearth furnace lined with silica. The stock from which this steel is made shall consist entirely of pig iron, or of pig iron and acid open-hearth scrap. When acid open-hearth scrap is used for stock it shall not exceed 25% of the furnace charge. No portion of the stock used shall contain more than .10% of phosphorus, or more than .05% of sulphur. The use of iron ore for the reduction of carbon in the furnace charge will be permitted according to usual and good practice. During the reduction of steel in the open-hearth furnace it shall not be decarbonized below .10%. The recarbonization of steel and addition of manganese shall be accomplished by the use of ferro-manganese or spiegeleisen only and shall be performed in a careful manner, most likely to give uniform results. The finished steel shall not contain more than the following proportions of the elements named: Phosphorus, .07%; sulphur, .04%; manganese, .50%; silicon, .10%; copper, .02%. Specimens cut from the finished material shall have the following physical properties:

Material.	Strength in lbs. per sq. in.	Elong. % in 8 ins.	P. C. reduction of area.
Shapes and universal mill plates	60,000 to 68,000	22%	44%
Sheared plates	60,000 to 68,000	20%	44%
Rivet rods	54,000 to 60,000	25%	50%

Specimens cut from plates and shapes shall bend cold 180° around once the thickness of the specimen; when at or above a red heat, 180° flat; and, when quenched in water at a temperature of 80° F., 180° around three times the thickness of the specimen. Specimens cut from rivet rods shall bend 180° flat when cold, when at or above a red heat, or when quenched from a light yellow heat in water at a temperature of 60° F. The elastic limit of the steel shall not be less than one-half of the ultimate strength. The finished steel shall be made into bottom cast ingots weighing not more than 5,000 lbs. each and cast in groups of not less than six ingots to each group. All bending tests shall show no signs of fracture on the outside of the bent portion. The fracture of all tension tests shall have a cup or angular shape and shall show a fine silky texture, of a bluish gray or dove color, free from black or brilliant specks. All rolled or forged material shall be entirely free from piping, checks, cracks and other imperfections, and shall have smooth finished surfaces. Rivets cut out of the work, when required by the Engineer or his representative, shall be tough and show a silky texture without crystaline appearance.

Steel for Castings.—Steel for castings shall be made in an open-hearth furnace lined with silica. At least one-third of all stock used for steel castings shall be pig iron; and, where scrap is used, it shall be of a kind and quality satisfactory to the Engineer. During the reduction of the steel in the furnace, it shall not be decarbonized below .10%. In making steel for castings, the use of iron ore, ferro-silicon, ferro-manganese and spiegeleisen will be allowed according to usual and good practice. The finished steel shall not contain to exceed the following limits of the elements named: Phosphorus, .06%; sulphur, .04%; manganese, .80%; silicon, .35%. All steel castings shall be carefully and thoroughly annealed. All castings shall be sound and as free from blow holes as the latest and best practice can produce. Test pieces taken from coupons on the annealed castings shall show an ultimate strength of not less than 60,000 lbs. per sq. in., an elongation of not less than 20% in 2 ins., and shall bend 90° around three times their thickness without rupture. All steel castings must be true to the drawings, with smooth surfaces, and all re-entrant angles must be neatly filetted. They must be planed smooth and true where the drawings require, and all holes for bolts must be drilled accurately.

Riveted Work.—All plates and angles to be riveted, which do not exceed ¾-in. in thickness, shall be punched ¼-in. less in diameter than the rivets to be used; and, after being straightened, shall be assembled and reamed to the size proper to admit the rivets. Those thicker than ¾-in. shall be assembled and drilled to the proper size to admit the rivets, without punching. The plates and angles shall then be taken apart, and all fins shall be removed from the edges of the holes by a countersinking tool, which shall slightly filet them. All sheared edges must be removed by a planer to a depth of at least ⅛-in. Surfaces to become inaccessible shall then receive a protective coating, to be approved by the Engineer, after which they will again be assembled and thoroughly and tightly bolted.

Riveting.—Wherever practicable, all rivets shall be machine driven, both in the shop and in the field. Whenever hand-riveting is necessary, the entire driving must be done with sledges weighing at least 8 lbs., and the rivets must be held by dollies capable of holding them firmly against such driving. All rivets must thoroughly fill the holes, have full hemispherical heads concentric with their bodies, and grip the work tightly. All work must be kept thoroughly and tightly bolted while the rivets are being driven, and all members must be true and out of wind when completed. Great care must be taken that all rivets are properly heated, and no overheated rivets shall be driven in the work.

Removal of Mill Scale.—Previous to assembling for riveting, all steel shall have the mill scale entirely removed, and must be fully protected from rust, either by oiling or painting, till it is ready to leave the shop, when all grease and dirt shall be removed, and it shall be immediately covered with a thorough coating of such paint as the Engineer shall approve. After this coating is dry and before shipment, the several pieces shall receive a second coating of the same paint.

Abutting Ends, Splices and Gussets.—All abutting ends and edges shall be milled or planed, so that the parts shall fit neatly and tightly together. All joints must be assembled after milling, and the holes in the splice plates and gussets must then be reamed or drilled, so that they will agree perfectly.

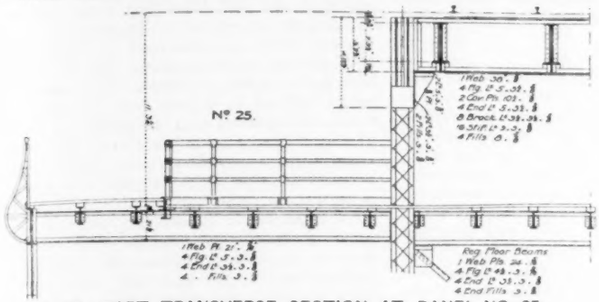


FIG. 18.—PART TRANSVERSE SECTION AT PANEL NO. 25.

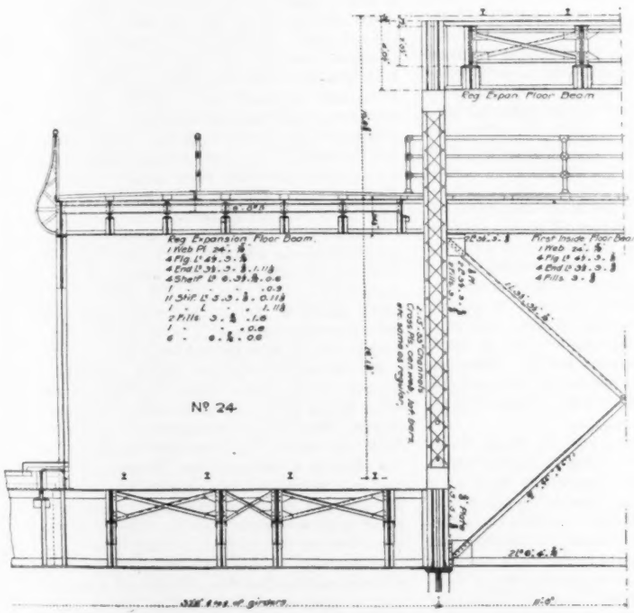


FIG. 17.—PART TRANSVERSE SECTION AT PANEL NO. 24.

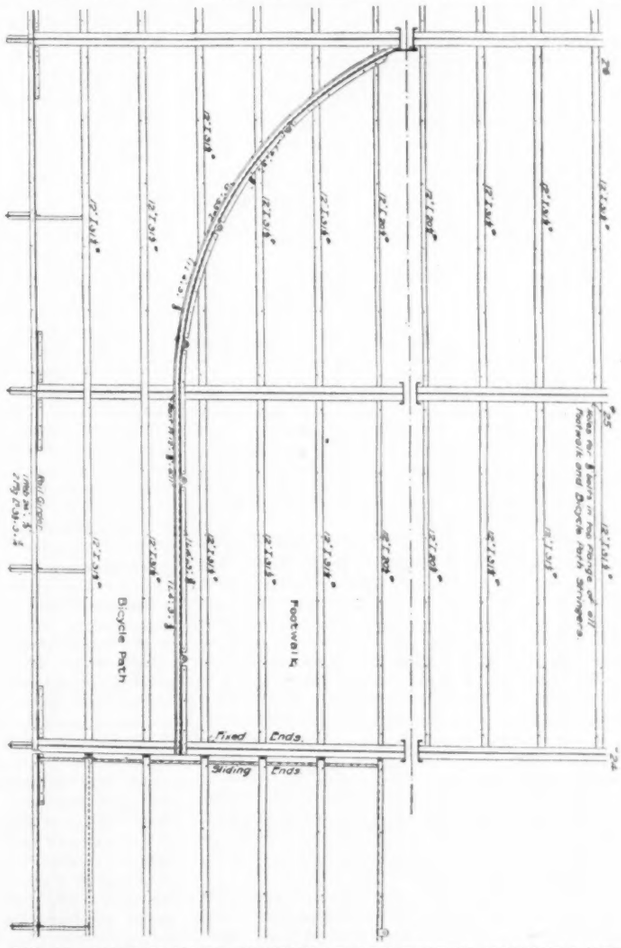


FIG. 19.—HALF PLAN OF FOOTWAY FLOOR SYSTEM AT PANELS NOS. 24 AND 25.

SUEZ CANAL TONNAGE for 1899 amounted to 9,893,022 tons, carried by 3,480 vessels, says Vice-Consul General Hunter, of Cairo. The tolls aggregated $17,510,142, and the business was the largest in the history of the canal. Of the ships passing the canal 2,207 were English, 378 German, 223 French, 205 Dutch and 102 Austrian. The United States sent only 25 ships through the canal.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post-Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY

GEO. H. FROST, - - - - - - - - - PRESIDENT.
D. McN. STAUFFER, - - - - - - - VICE-PRESIDENT.
CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
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ALFRED E. KORNFELD, New York, M. C. ROBBINS, Chicago, S. B. READ, Boston, C. F. WALKER, Cleveland, } ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 170 SUMMER ST., ROOM 404.
CLEVELAND OFFICE, OSBORN BUILDING.
LONDON OFFICE, EFFINGHAM HOUSE, 1 ARUNDEL ST., STRAND.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00. To all other countries in the Postal Union: Regular Edition, One Year, $7.00 (31 shillings); Thin Paper Edition, One Year, $6.31 (26 shillings). SINGLE COPIES of any number in current year, 15 cents.

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ADVERTISING RATES: 20 cents a line. Want notices, special rates, see page XXI. Changes in standing advertisements must be received by Monday morning; new advertisements, Tuesday morning; transient advertisements by Wednesday morning.

The Lake Shore & Michigan Southern Ry. has long been noted for its large average freight train load, and its low average freight rate per ton mile. The annual report for the year 1899, just issued, shows that a new record was made by the company, much surpassing its average record in former years. According to the figures given in the report, the average freight train load in that year was 427.3 tons, and the average freight revenue per ton-mile on all classes of freight was reduced to 4.71 mills. Compared with 1898 this is an increase in the average freight train load of no less than 75 tons, and a decrease in the freight revenue of 0.31 mill. The average cost to the company of moving all freight is put at 3.2 mills per ton-mile, which is also a reduction from the lowest previous record made in 1898.

It is noteworthy that a great increase in freight train loads on the Lake Shore has been made since 1894, when the average load was only 267 tons. With this increase in the average load has come a slight increase (about 6 cts.) in the average expenses per freight train mile; but the earnings per freight train mile have increased in the same time about 45 cts., and the total net earnings of the company were $1,410,000 greater in 1899 than in 1894. These figures do not indicate that such low freight rates as those above indicated are not compensatory on roads of sufficiently heavy traffic. In fact their adoption appears to be an example of sound business policy.

Some English experiments upon the effect of speed of circulation on the rate of evaporation in boiler tubes were reviewed editorially in our issue of Jan. 18 last. The experiments were made by Mr. Geo. Halliday, and reported to the British Institute of Marine Engineers. They appeared to show that the rate of heat transmission from the hot gases to the water in the tube decreased with increased speed in circulation. We showed in our issue above referred to that such results were contrary to all previous experience and accepted theory, and were undoubtedly incorrect for reasons which we pointed out in detail.

A French engineer has now repeated Mr. Halliday's experiments, using similar but more accurate apparatus, and has obtained directly contrary results. He finds that the rate of heat transmission increased rapidly with increase in the speed of circulation until a speed of flow of 20 ft. to 50 ft. per minute was reached, when the rate of increase became more slow. There was still some increase in heat absorption, however, for each increase in the speed of circulation up to the final point to which the experiments were carried.

It is interesting to note that whereas Mr. Halliday's original paper has been reprinted without comment or criticism in a large number of engineering periodicals, the only journals which have called attention to its manifest errors, so far as we have learned, are Engineering News and "Power," in the United States, and one French society publication.

The report on the metric system which was presented by one of the committees of the American Railway Association at the recent meeting in Chicago, and of which we give an abstract in another column, contains neither recommendations nor suggestions as to the use or introduction of this system. It is simply a condensed statement of the present status of the system in this country, as regards legislative action and practical use, and as such it is of interest. It appears that there has been no actual legislation by Congress on this subject since the law of 1866, which made the use of the metric system legal and optional, but not compulsory. A few State legislatures have also passed laws having the same intent. In regard to the practical use of the system, the report appears to show that considerable progress has been made in many lines, largely in connection with manufactures for export. The summary forming the latter part of the report indicates that sufficient progress has been made to refute the arguments sometimes made in opposition to this system to the effect that its introduction would be impracticable. Thus we find it used in several of the government departments, in electrical engineering work and in a variety of manufactures. As the export trade of the United States has had a marked influence upon the introduction of the system up to the present time, the recent growth in the export trade will probably cause a further increase in the use of the metric system. This cannot but have a reflex influence upon its use in manufacturing industries in general, for the difficulties and annoyances incident to the use of two systems of measurement will become increasingly evident.

The office of Superintendent of the State Land Survey of New York was abolished by a bill which passed the late New York legislature on March 28, and has now received the Governor's signature. This act repeals the act of 1895 creating the office of the Land Survey; and a clause in the Revised Statutes of 1892, which designates the State Engineer and Surveyor as the custodian of all surveying instruments, notes and records belonging to the State, gives this latter officer legal authority over all the records of the Land Survey, and leaves him to continue the work done by that survey. This is a change in the proper direction, as it leaves one man—and the proper official—in charge of the surveying and engineering work of the State, and will avoid the conflict and duplication of work that resulted from the previous arrangement. As noted in our recent review of the last published report of the late Superintendent of the State Land Survey, the public will lose little by the suppression of that survey.

As we predicted two weeks ago, the House of Representatives passed the Hepburn Nicaragua Canal bill on May 2. The vote on the final passage stood 224 to 35; but in the debate preceding the final vote many of those who finally voted in favor of the bill expressed their dissatisfaction with many of its provisions and their expectation that it would receive amendment in the Senate. As one member expressed it:

> While this bill may not be perfect, I am for giving it a shove now into the hopper of legislation, so that it may come out a finished product eight or nine months hence.

From general reports, there appears little likelihood that the Senate will seriously take up the bill at the present session of Congress. Its passage in the House seems to have been largely for political effect, with the understanding that final action will not be taken until the next session of Congress, when the Isthmian Canal Commission will have completed its work and the Clayton-Bulwer treaty will, it is presumed, have been abrogated.

THE STORY OF THE SAVANNAH HARBOR WORK.

The commitment to the Leavenworth Penitentiary on April 26 of ex-Capt. Oberlin M. Carter, to serve his sentence of imprisonment for conspiracy to defraud the United States Government, marks the final termination of a most remarkable criminal case, and one which has been followed with the deepest interest by the engineering profession. We risk little in saying that when the reports of irregularities in the Savannah Harbor work were first made public in August, 1897, engineers generally refused to believe that an officer of the Corps of Engineers with the ability and reputation of Capt. Carter could have been guilty of anything worse than some technical infractions of the regulations under which Government contract work is carried on. Capt. Carter's many personal friends were outspoken in his defense, and other members of his profession felt that the proper thing to do was to suspend judgment and wait until the charges against him had been heard and passed upon by the proper authorities.

That took place. Two successive tribunals, one a board made up from his own corps, the other a court martial of his brother officers, spent months in the most painstaking investigation of these charges; and he was found guilty and sentenced. The delays in the execution of that sentence, the herculean attempts made by his attorneys to set him free on trivial technicalities, to blacken the character of all who took part in his prosecution, and in general to create public sympathy for him as a second Dreyfus, have all been suitably commented upon in these columns and we need not refer to them further now.

What we do propose to do is to describe, as well as brief space permits, first the work on which Capt. Carter was engaged in which the frauds were perpetrated, and second the chain of evidence upon which a jury of his peers pronounced him guilty, which evidence stands approved by every higher official who passed upon it.

The Savannah Harbor, which was the most important work under Capt. Carter's charge, consists of the lower or tidal course of the Savannah River. The city of Savannah is nearly 25 miles from the sea as the river runs; and the course of the river is a tortuous one through alluvial lands and swamps with islands which for the most of the distance divide the stream into two channels. The river carries a large volume of sediment; any obstruction to the current causes this to be deposited, forming shoals. In 1873 the usual draft of vessels navigating the river was about 14½ ft., and a project was submitted by the late Gen. Quincy A. Gillmore to improve the channel and obtain a depth of 22 ft. of water. This project was modified from time to time and piecemeal work was done on various parts of the river's course until 1890. The total appropriations by Congress during this time were $1,200,000 and the depth of the river was increased so that vessels with 21 ft. draft were able to navigate it.

Lieut. Carter was graduated from West Point in 1880 and in 1884 he was sent to Savannah as an assistant to Gen. Gillmore and later to Gen. Abbot. In 1888 Lieut. Carter was placed in responsible charge of the work in the Savannah district. In the same year he submitted a project for improving the Savannah River to obtain a depth of 28 ft. of water from Savannah to the sea, and this project, modified to provide for a depth of 26 ft., was adopted in 1890. The total cost of the work was estimated at $3,500,000, and in 1892 legislation was passed permitting a contract to be made for the completion of the entire project.

The method by which the deepening was proposed to be accomplished was the confinement of

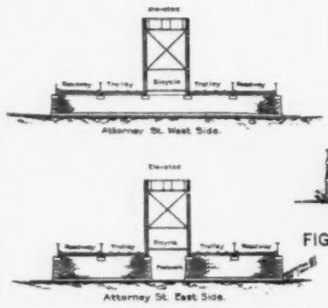


FIG. 3. TRANSVERSE SECTIONS OF APPROACH AT ATTORNEY ST.

FIG. 4. TRANSVERSE SECTION OF APPROACH AT RIDGE ST.

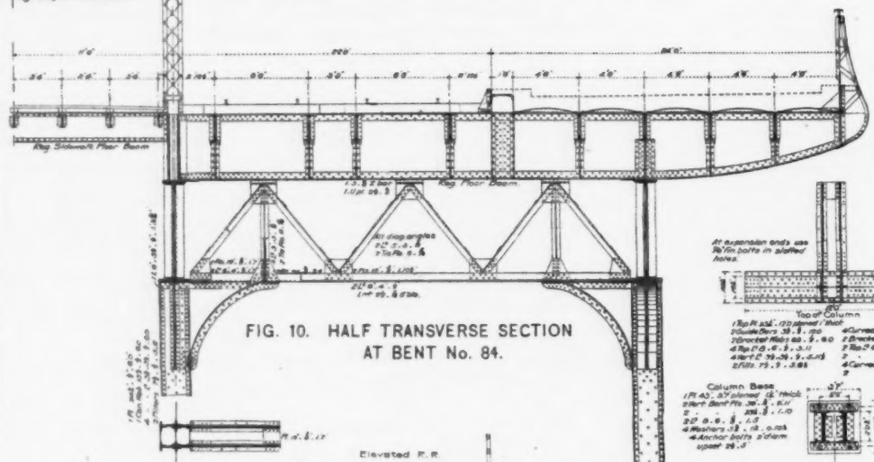


FIG. 10. HALF TRANSVERSE SECTION AT BENT No. 84.

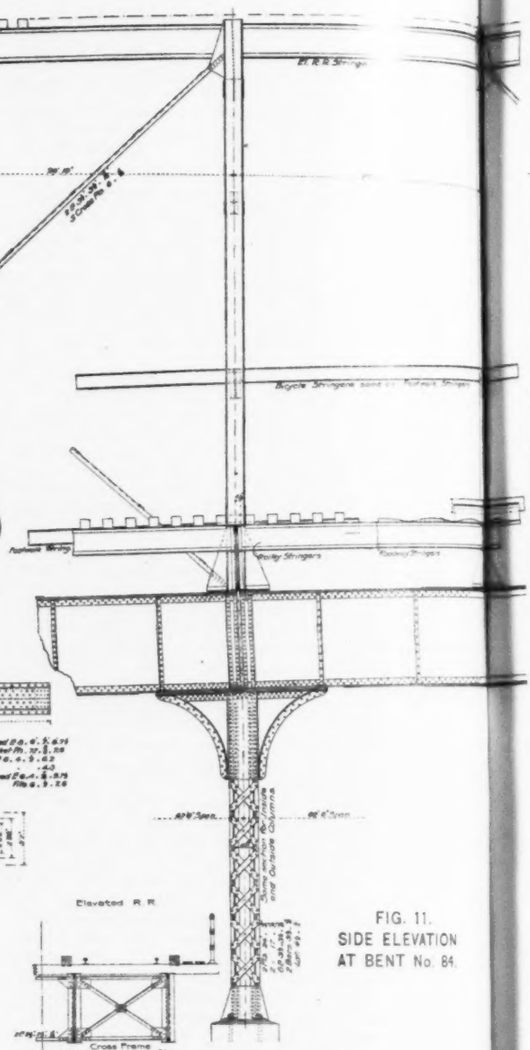


FIG. 11. SIDE ELEVATION AT BENT No. 84.

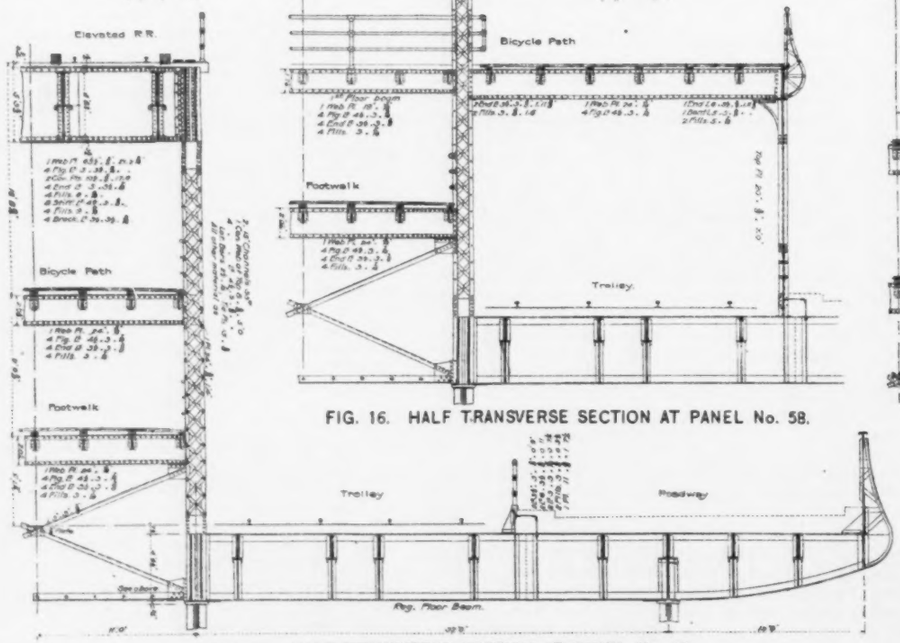


FIG. 14. HALF TRANSVERSE SECTION AT PANEL No. 60.

FIG. 16. HALF TRANSVERSE SECTION AT PANEL No. 58.

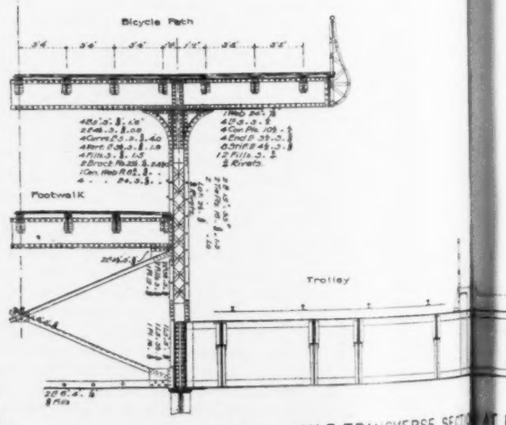


FIG. 15. HALF TRANSVERSE SECTION AT PANEL

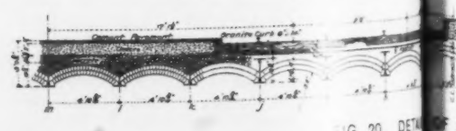


FIG. 20. DETAILS OF FLOOR

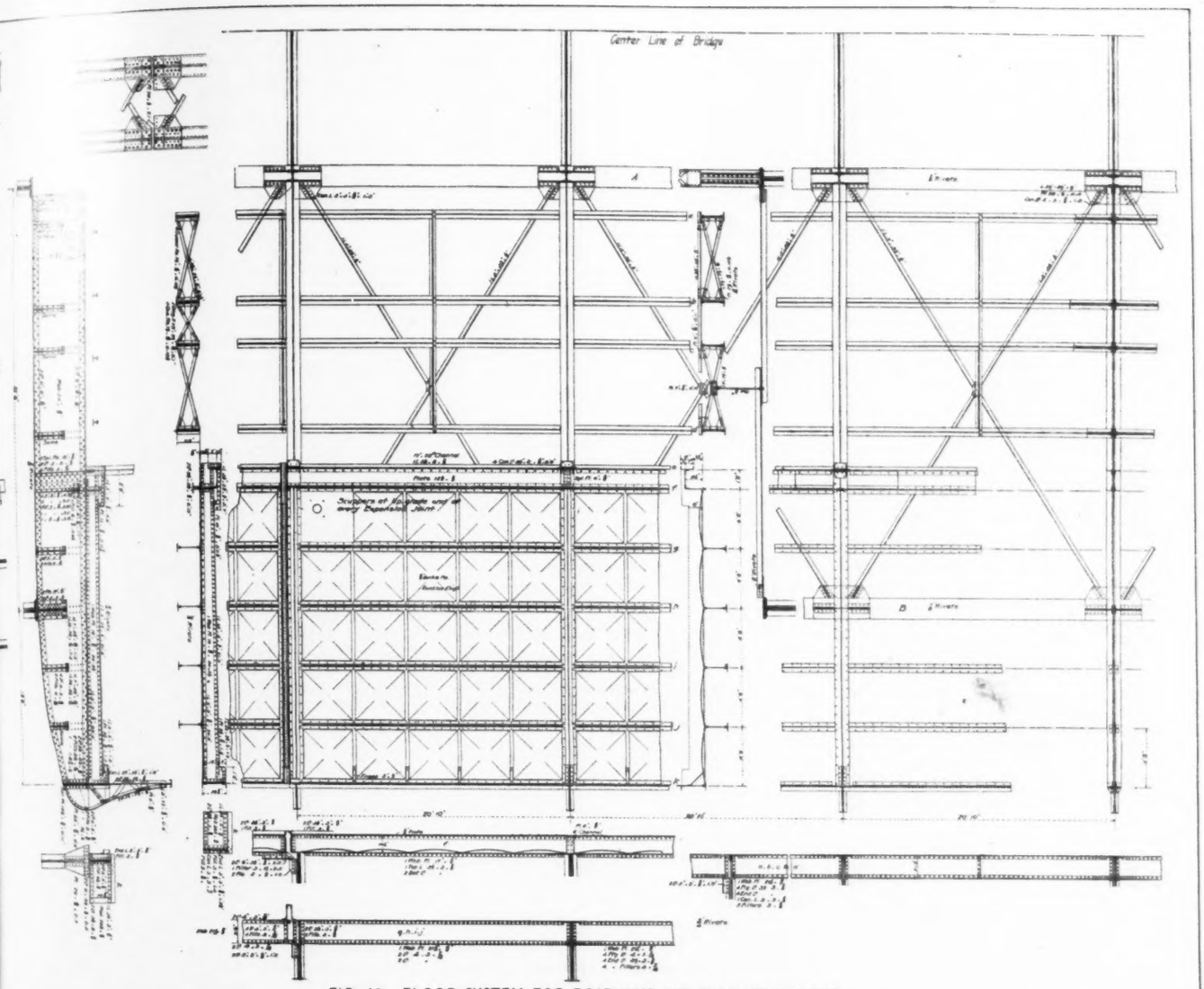


FIG. 13. FLOOR SYSTEM FOR ROADWAYS AND TROLLEY TRACKS.

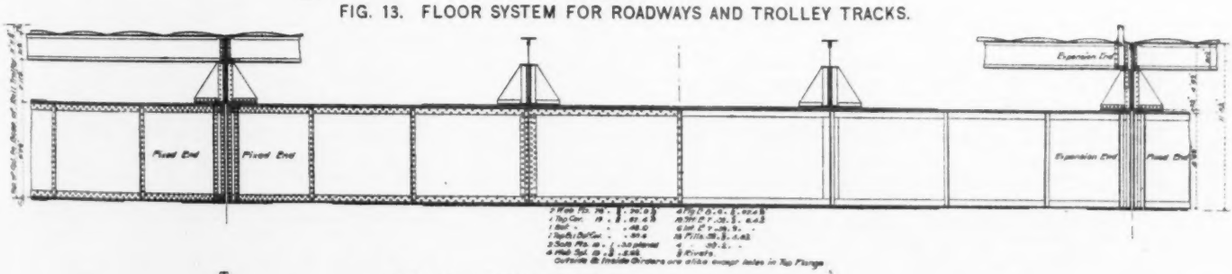
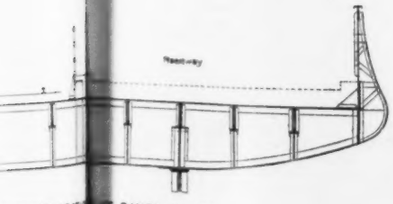


FIG. 12. DETAILS OF 62½ FT. PLATE GIRDERS.



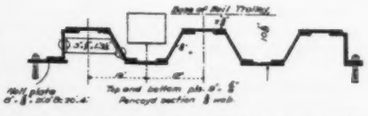


FIG. 7. DETAIL OF TROUGH FLOORING FOR SPAN OVER ATTORNEY ST.

SVERSE SECTION AT PANEL No. 59.

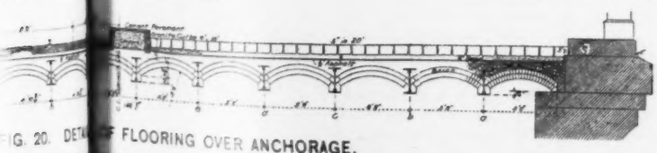


FIG. 20. DETAIL OF FLOORING OVER ANCHORAGE.

NEW YORK APPROACH

FOR THE

NEW EAST RIVER BRIDGE.

L. L. Buck, M. Am. Soc. C. E.,

Chief Engineer.

CHAS. HART, LITH., 30 VESEY ST., N. Y.

the river by training walls, as they are called, by which the flow of the tidal currents was expected to be concentrated, and the silt brought down by the river was to be kept in suspension until it could be swept out to sea by the ebb tide. In addition to this, extensive dredging was provided for to assist the currents in forming and maintaining the channel.

The work was completed in 1896, and during its progress over 6,000,000 cu. yds. of material was dredged from the channel. The required depth of 20 ft. of water was reported by Capt. Carter in 1896 to be attained; but the probabilities appear to be that the deepening was due to the dredging rather than the training walls.

The Chief of Engineers in his last report states that the work "resulted in a channel depth of about 20 ft. at mean low tide, obtained principally by dredging and maintained to some extent by training walls. This channel, however, was narrow and crooked and has since shoaled quite rapidly."

Capt. Carter himself, in one of his official reports, acknowledged that the deepening of the river by the training walls had been less than was expected and ascribed it to the existence of a bed of stiff marsh mud found in the bottom of the river which did not yield to the current. Capt. Carter's successor at Savannah in his last report says that the training walls are correctly located and ought theoretically to do the work they were designed to do. He thinks their failure is probably due to the fact that they are too low, their crests being in many places 6 ins. to 30 ins. below low water mark. About 427,000 cu. yds. of material was dredged from the channel last year, and even this did not keep up with the shoaling, only 17½ ft. of water at low tide being reported at one point.

The river appears to deposit nearly all the silt which it brings down in the navigable channel, where it has to be dredged out. While the training walls may be of some benefit in keeping the channel clear, it is plain that they do not do the work they were expected to do when the project for their construction was adopted.

These facts regarding the training wall work are of especial interest, because frauds and collusion with the contractors on this class of work was the principal charge on which Capt. Carter was found guilty. The contractor for the Savannah Harbor training walls was the Atlantic Contracting Co., and the total amount which it received for their construction was $2,356,720. One of the points on which the defenders of Capt. Carter laid most emphasis was the great ability displayed and the important public service which he had performed in originating and carrying to a successful conclusion the work of deepening the entrance to the port of Savannah. Of course this has little to do with the real questions before the court which tried him; but it is well to point out here the fact that the works can by no means be called an engineering success, and that the expensive training walls, costing over $2,000,000, are giving no benefit to the river at all commensurate with their cost.

Turning now to the detailed construction of these training walls: Those used on the Savannah River were of two kinds, known respectively as pile dams and mat dams. The pile dams were made by driving two parallel rows of piles 6 to 8 ft. apart, the piles being 8 ft. apart in each row, and filling the space between them with brush tied in bundles and held down by a load of limestone. The mat dams were used mostly on the lower part of the river, where the water was more salty, more trouble was likely to be caused by marine worms, and the dams were likely to be exposed to heavy seas. They were made by depositing on the bottom of the river one or more courses of brush mattresses 75 to 100 ft. in width, and filling on top of them with broken stone.

It was the enormous amount of brush mattresses used and the high price paid for them that formed the basis for the most important charges against Capt. Carter. On the Savannah River improvement, the Atlantic Contracting Co. built 43,177 lineal feet of mattress training wall and used 1,431,751 sq. yds. of mattresses in them. In the original project for the work Capt. Carter estimated the amount of these mattresses as only 350,000 sq. yds. and their cost at 60 cts. per yd., but the contract was let to the Atlantic Contracting Co. at 95 cts. per sq. yd. and the amount used was four times the original estimate.

These mattresses are (or should be) made up of tightly bound bundles of brush, or facines, as they are technically termed. The brush is laid in the fascine so as to break joints, is compressed by a lever and chain device termed a "choker" and is tied tightly at frequent intervals so that it finally forms a compact round bundle some 9 ins. in diameter and long enough to extend the full width of the mattress. As these bundles are built up they are placed close together side by side, and either a second layer of similar bundles or a grillage of poles is laid on top of them at right angles. To hold the whole together, binding poles are placed on top and bottom, extending across the mattress at right angles to the fascines, and wires are carried from the poles on top around those on the bottom so that all the poles and fascines are bound tightly together.

It will be apparent from the above description that the cost of executing mattress work and its value and stability when completed depend very much on the manner in which it is done and the methods adopted for doing it. At Savannah, not only were brush mattresses used to an extent almost or quite unprecedented in engineering work, but methods were adopted which greatly reduced the cost of the work to the contractors.

As stated above, 1,431,751 sq. yds. of brush mattresses were used on the Savannah Harbor work and 43,177 lin. ft. of mat dams were built. This would give an average width of nearly 300 ft. if the mattresses were only one course deep. As a matter of fact, however, Capt. Carter made use of so-called "multiple mats," or mattresses in successive layers to a remarkable extent, and it is this which accounts for the enormous amount of brush mattress used in his work.

In much of the mattress work on the South Atlantic Coast the mattresses have been built on shore, launched, towed to position and sunk. On the Savannah work the mattresses were built on barges, so designed that the mattress could be launched directly from the barge. Besides this, the plan was devised of building the "multiple mats" on the barges and launching four or five of them at once. The economy of this will be obvious. At one trip of the tug and barge a whole series of mattresses would be placed. In some of the work done by these contractors as many as eight courses of brush mattress were built and launched together.

The question now comes: What profit did the Atlantic Contracting Co. make on this mattress work. Its members had an opportunity at Capt. Carter's trial to show their force and material account and make clear to the court whether the profits they had received were exorbitant or not; but B. D. Greene, of this company, evaded under cross-examination every attempt to secure this information and swore that no record was kept of the expenditures on the work, notwithstanding the enormous amounts involved. From the testimony before the court, however, it would appear that the cost of the mattresses to the contractors was somewhere from 15 cts. to 60 cts. per sq. yd., with the probabilities in favor of a figure much nearer the lowest than the highest sum named.

Had the mattresses all been built in a first-class manner, in accordance with the best engineering practice, the cost might have reached the higher figure; but abundant evidence was offered that the work on which these contractors was engaged was executed in anything but a first-class manner, and that its cost to them was thus greatly reduced.

In the figures for the quantity of work done, given above, we have alluded only to the work on Savannah Harbor proper under the 1890 project, as it is termed. It should be noted, however, that in the court martial of Capt. Carter any fraudulent transactions in his conduct of this work were debarred from consideration by his plea of the statute of limitations at the outset of his trial. The specific work on which charges were brought, therefore, was that performed by the Atlantic Contracting Co. on a jetty near the mouth of the Savannah River, designed to protect the anchorage in Tybee Roads, and on jetties at Cumberland Sound, the entrance to the port of Fernandina, Florida. On both these works, Congress authorized contracts to be made for the completion of the entire project, and the jetty work was in each case let to the Atlantic Contracting Co. at 95 cts. per. sq. yd. for the brush mattresses on the Tybee Roads work and $1.10 per sq. yd. for the mattresses on the Cumberland Sound work. Capt. Carter's estimate of cost for the Tybee Roads jetty was about $1,000,000, and about $367,000 had been spent on the work when it was suspended soon after the charges were brought against Capt. Carter. The estimate for the Cumberland Sound work was $2,350,000, and about $604,000 worth of work had been done by the contractor when operations were suspended in October, 1897. When the work stopped, the contractors had put 211,676 sq. yds. of brush mattresses in the Tybee Roads jetty and 458,157 sq. yds. in the Cumberland Sound work.

It was in the Cumberland Sound work that the greatest use was made of "multiple mats." Six and eight courses of mattresses 80 ft. to 100 ft. in width were sunk in these jetties, and the character of the work was such that when Capt. Carter's successor first inspected it on taking charge of the district, he found and photographed mattresses so flimsily constructed that they were little more than big brush heaps squared up at the corners with a few pine poles laid through the mass. The percentage of profit of the contractors on this sort of work can be readily imagined.

A most peculiar thing in connection with the Cumberland Sound work was the manner in which the mattress work was increased over the estimates. The project for this work was approved by a Board of Engineers in December, 1895, and they provided for a jetty section "composed of a foundation of brush mattresses with a load consisting of a hearting of small stone covered with heavier stone." In carrying out the project, however, Capt. Carter used at places as many as 14 courses of brush mattresses in the jetty, and while his own estimates called for only 425,000 sq. yds. of mattresses in the entire work, there had been used over 458,000 yds. in building only a small part of the work, when operations were suspended.

The explanation offered by Capt. Carter was that the mattresses were cheaper than stone and hastened the completion of the work. As actually built in the jetty, however, the mattresses compressed so much that their cost per cubic yard was far greater than the cost of rock, while their durability in these teredo-infested waters is at best problematical.

Besides the brush mattresses, for which it was alleged Capt. Carter paid excessive prices, other items in the Atlantic Contracting Co.'s work were shown on the trial to afford exorbitant profits. In the Cumberland Sound jetties, for example, Florida limestone was furnished by the contractors at $3.90 per cubic yard, when its actual cost in the work was about $2.00.

Taking it as proved that enormous profits were made by the firm of contractors above named in their work under Capt. Carter, it did not follow, of course, that he was guilty of any more serious crime than neglect to secure proper economy in the conduct of his work. Many an engineer is so placed at times that he has to pay excessive prices for work; and it is, we fear, sometimes true that engineers engaged in government or municipal work, consider their duty done, so far as prices for the work are concerned, when they have complied with the procedure established by law to secure free competition in letting contracts.

We do not take that view of the matter. If Capt. Carter merely let contracts at prices which he knew afforded an excessive and exorbitant profit to the contractor, he deserved for this alone censure and punishment. An engineer is a trustee, bound morally and legally to use the same ability and economy in the conduct of the work under his care as if it were his own, and responsible for any breach of this trust.

In the trial of Capt. Carter, however, the excessive profits which the Atlantic Contracting Co. made were only one link in the chain of evidence against him. It was shown that Carter had been for many years on terms of peculiar personal in-

timacy with the members of this firm, extending to partnership with them in certain outside ventures. With one exception, this firm of contractors under one name or other had done all the jetty and training wall construction in Capt. Carter's district for many years. In the letting of some of the contracts which the favored contractors obtained, peculiar methods were followed. The time of advertising was made as short as possible; obstacles were placed in the way of possible bidders obtaining copies of the specifications; and precautions were apparently taken that no unknown bidder should get a chance to present a bid. The specifications for the Cumberland Sound work were so drawn as to permit the use of three different designs of mattress, at the option of the engineer. No outside bidder could safely estimate on anything but the most expensive of these designs. When the Atlantic Contracting Co. got the contract, however, the cheapest class of mattresses was ordered by Carter.

It will be apparent to every engineer and contractor that a specification which leaves to the option of the engineer the use of three different classes of material differing largely in cost, and this material the most important item of the work, is a specification wholly unfit for use when a general invitation is given to bidders. Yet when the charges against Carter were first made public he declared to one of the oldest officers of his own corps that the idea had never occurred to him that specifications so drafted were in any way objectionable or could be used as a means of collusion between an engineer and a contractor. Of just such lame attempts at explanation did his defense largely consist.

Space forbids further statement of the evidence of a fraudulent partnership between Carter and these contractors which was brought out on the trial; nor is there need to present it; for the most convincing and irrefutable evidence of such collusion and its results was furnished through the finding of large sums of money in Carter's possession and his failure to satisfactorily account for them.

In the review of the case made by Attorney-General Griggs in September last, he gave a searching analysis of Carter's financial transactions. Summarizing this briefly, it appears that beginning in 1891 Carter's personal expenses increased in rapid ratio from $6,047 in 1891 to $29,611 in 1896. In 1892 he began to buy securities through brokers in New York and continued until by the end of 1895 he had accumulated over $450,000 worth, yielding him an annual income of over $25,000 from interest and dividends. Carter's explanation of the source of this wealth was that it was given him by the father of his deceased wife, Mr. R. F. Westcott, who had conceived for him an extraordinary affection; and he claimed further that the securities really belonged to Mr. Westcott. This story was unsubstantiated by any testimony from Mr. Westcott, and was on its face, especially when examined in detail, too extraordinary to be accepted on the word of the accused man alone. On this point Secretary Griggs said:

> If it be true, as contended, that Mr. Westcott had such an extravagant affection and regard for his son-in-law as to induce him to confide to him so great a trust and to make him the donee of such large sums of money, then the natural suggestion would be that he would be interested intensely in the result of the trial in which the honor as well as the liberty of his son-in-law was involved. One would naturally think that a father-in-law so regardful of his son-in-law's interests would be quick to rush to his defense and by his oath to add confirmation to the story, which, if true, would exculpate him from these serious charges.
>
> It is said that Capt. Carter made great efforts to secure the attendance of Mr. Westcott as a witness, but there is no proof of it. There is no evidence that he wrote him or requested him in any wise to appear as a witness before the court-martial. The inference is that his testimony would not have benefited Capt. Carter if he had appeared. Such is the irresistible conclusion, and, therefore, finding that the one witness in all the world who could have created conviction in the minds of the court as to the truth of this extraordinary story withholds himself, and that there is no satisfactory evidence that the defendant made any exertion to produce him, we must conclude that his testimony would not have been useful.

Subjecting to expert analysis the dealings between Carter and his father-in-law, as shown by the accounts, check-books, etc., put in evidence, it appears that their transactions were on a strict business basis. Certain moneys were in fact deposited by Mr. Westcott in the bank account of Capt. Carter; but it appears that almost at the same time Capt. Carter paid Mr. Westcott the exact amount of the deposit. Could better evidence be desired that Capt. Carter preferred to put certain moneys through this channel in order that they might appear to have been a gift to him from his father-in-law?

It is also important to note the peculiar methods adopted by Carter for the payment of these Savannah Harbor contractors. Almost invariably when moneys were to be paid to the Atlantic Contracting Co. Capt. Carter would visit New York, hand the contractors the check himself and the check, instead of being deposited in a bank and collected through the clearing house, was frequently presented for payment in cash at the subtreasury. Still more peculiar is the fact that closely coincident with the cashing of these checks by the contractors was the purchase of bonds by Carter. Mr. Griggs gives no less than nine instances where Carter's purchases of bonds were made simultaneously with the payment of checks to the contractors.

Since the refusal of the U. S. Supreme Court to interfere in Carter's case, further information has been made public by the expert accountant who analyzed the exhibits in the Carter case for Secretary Griggs. These point most strongly to a division between Carter and the firm of Gaynor & Greene on the basis of one-third to each. Repeated instances are shown where simultaneously with the cashing of checks by the contractors, Carter deposited or bought bonds to just one-third of the amount paid in the Government check.

The crowning and absolutely conclusive certificate of Carter's guilt, however, has been furnished by the published statement of his father-in-law, which appeared on April 30 in the daily press. According to this, Mr. Westcott now publicly denies that he ever gave moneys to Carter and has given the government full access to all his books and private papers for use in the prosecution of Carter's co-conspirators. Further than this, while it appears that Carter did make Westcott a depository of moneys and securities, when the charges against Carter were made public in 1897, Westcott refused to keep these securities longer, and he turned over to Carter and received his receipts for securities aggregating over $400,000 in value.

In view of such convicting and convincing evidence as this, of what avail can be Carter's repeated hysterical protestations of innocence, save to add to his character the further taint of hypocrisy?

As our readers will remember, we gave space in these columns in our issue of September 28 last to a letter from Capt. Carter himself, in which he began with the assertion that he was conscious of his own innocence, and attempted to review his case and refute and impeach a part of the testimony against him. In fact, a particularly strong effort has been made to impress upon the engineering profession the idea that Carter was unjustly convicted. One of our contemporaries devoted much space last fall to an effort to prove that there was a mistake somewhere in his conviction. In one of the engineering societies, also, a paper was read and published in its transactions, in which an attempt was made to defend Carter and impeach the evidence on which he was convicted. Other evidence has reached us showing the existence of a more or less widespread feeling among engineers of sympathy for Carter as a man unjustly convicted. It is because of these various facts that we have deemed it proper to lay before our readers actual facts from official records in connection with this case, that correct opinions concerning it may be formed.

We need hardly say that the above brief review is only the barest outline of a small part of the evidence relating to a single one only of the charges. Whether the other charges relating to matters of minor importance were proved or not—or, as one man phrased it, "whether Carter stole little as well as stole big"—is of little consequence. The minor charges were included in his trial, we imagine, to show the character of the man, and while it may be a question whether the evidence presented was legally sufficient to prove them, it was in fact sufficient to convince the officers who sat in the court martial.

In his present attitude Carter deserves not even the sympathy of the profession of which he was once a member. His protestations of innocence can no longer deceive any one. His crime was an offense against his professional brethren as well as against the Government that placed such great trusts in his charge. He used every means, fair and foul, to escape conviction upon the charges brought against him, and when he was found guilty, resorted to every possible legal technicality in the endeavor to escape punishment.

More than this, sympathy for Carter is out of place as sympathy bestowed on a burglar who poses as a saint-like innocent while silverware bulges from his pocket. According to the statement of his own father-in-law, Carter must have in his possession several hundred thousand dollars in securities. So far as at present appears, he can serve out his sentence and walk out of prison four years hence in full possession of his ill-won fortune. It has been stated in the public prints that Carter feels to the fullest extent the depth of the disgrace which has come upon him. If he would reinstate himself in any degree in the respect of his former friends and fellow engineers, he ought as the first step to return this money to the Treasury, and then make full confession of his crime and assist by his evidence in the conviction of his co-conspirators.

Which is the dearer to him, the restoration of some remnant of honor or the retention of his ill-won wealth? He can have his choice; but he cannot have both.

LETTERS TO THE EDITOR.

Rusting of Wire Nails.

Sir: Noting the letter from Mr. Macy S. Pope, in your issue of April 5, regarding the rusting of steel wire nails, I can report a similar case. In 1898 I examined a saw mill building at Patterson, La., a steel frame building with corrugated galvanized iron roofing. The covering was fastened with steel wire nails clinched around the steel purlines. After four years many of these nails showed a loss from rusting of from 65% to 75% of their sectional area at a point just below the roofing. The excessive rusting was probably hastened by interior condensation, but is believed also to have been augmented by the proximity of salt water. The building is on the bank of the Bayou Teche. Galvanized nails were used in similar structures erected later. Sugar planters in the neighborhood reported steel wire nails very short lived when used in fences.

Yours truly,

H. J. Burt.

Chicago & Western Indiana Ry. Co., Engineer's Office, Chicago, Ill., April 22, 1900.

A Suggested Plan for Preventing the Breaking of Radial Roller Rods in Swing Bridge Turntables.

Sir: When rim-bearing swing-bridges are built in the usual manner, with rods extending from the spider to the rollers to hold them in position, it is not uncommon for one or more of these rods to be broken. These breakages are usually supposed to be caused by some of the rollers becoming slewed around so that they run toward the outer edge of the track. Now the rollers are connected together in such a manner that if one slews around they must all do so, an event which might prove disastrous to the

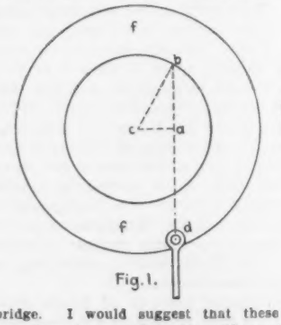


Fig. 1.

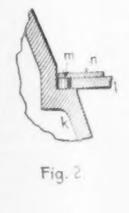


Fig. 2.

bridge. I would suggest that these breakages might sometimes be caused by the spider not turning properly. Let f f (Fig. 1) represent a spider; d e, one of the rods; c, the center of the center casting, and c b, its radius. Produce the center line of the rod d e to b, and draw c a perpendicular to d b. If, by the wind pressure or any other cause, a strain is put on the rods on only one side of the spider, the spider will not turn unless $\frac{a\,c}{c\,b}$ is greater than the coefficient of friction of the spider against

the casting, which may be .4 or more, and, as c b is often a foot or more, the breakage of rods is inevitable. I propose as a remedy for this, the arrangement shown in Fig. 2, in which k is the center casting, l the spider, m a ring of rollers extending around the casting, and n a ring riveted or bolted to l to hold them in place. This would make a roller bearing between the spider and the casting at a moderate cost, which should prevent the spider from jamming or sticking. Very truly yours,

Willis Whited.

[illegible] St., Pittsburg, Pa., April 23, 1900.

The Elgin Stand-Pipe Failure.

Sir: Yours of April 25, enclosing proof of articles you propose publishing on the recent failure of the Elgin stand-pipe, is at hand. We see nothing to add that would throw further light upon the subject. The stand-pipe evidently had been greatly weakened by the enormous strains brought upon it by the annual freezing for a period of 13 years, and it was only a question of time when it would inevitably give way.

If these stand-pipes were encased either with brick or wood so constructed as to admit a circulation of air, and a small fire kept at the base of the tower in exceptionally cold weather, we are of the opinion the risk from ice forming to any dangerous extent would be lessened to such a degree as to eliminate it as a factor of danger. All the stand-pipes in this city are incased in this way. We have repeatedly brought this subject to the attention of hydraulic engineers when we were contractors for the erection of stand-pipes, and trust that the breaking of the stand-pipe from falling ice at Elgin will prove a sufficient warning to all water-works operating them, to at once have them properly protected. Very truly,

John W. Harrison,
President Shickle, Harrison & Howard Iron Co.
St. Louis, Mo., April 27, 1900.

(The articles in question were published in our issue of May 3.—Ed.)

Methods of Interpolating Contour Points.

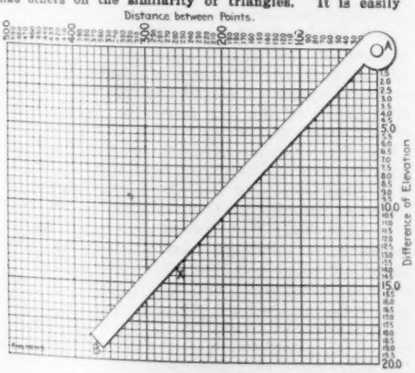
Sir: I note in your issue of March 29, Mr. Bedell's description of a diagram for interpolating contour points. In this section we have for a long time used this diagram in a simpler and more rapid manner, as follows: Draw the parallel equidistant lines he describes on transparent paper of some kind. Tracing cloth will do, but transparent profile paper is better, as it saves the drawing. Number the lines properly, and see that there are enough of them to provide for the greatest difference of elevations to be interpolated between. Finally draw on the map lines joining the points between which it is desired to interpolate.

Take for example two such points, A with elevation 52 ft., and B with elevation 68 ft. Place some point of the 52 line on the diagram (it would be marked simply "2") over the 52-ft. point A on the map, and stick a pricker point through the diagram and through this point on the map. Revolve the diagram about this point until its 68 line (which would be marked "18") passes through the point B on the map as seen through the transparent paper or cloth. Holding the diagram in this position note the intersection of its 60 line with the line joining A and B on the map; this is the 60-ft. contour point and may be pricked through the diagram to the map. Evidently 5-ft. or 2-ft. contour points might have been pricked through at the same operation.

I have no doubt that many of the readers of Engineering News have used the diagram in this way.

Yours truly, Robt. L. Lund.
Engineering Dept., Vanderbilt University, April 7, 1900.

Sir: After noting Mr. Bedell's means for plotting contour lines, the accompanying diagram is offered, depending like others on the similarity of triangles. It is easily



made from a piece of cross-section paper pasted on a sheet of cardboard with a straight-edge, A B, swinging around a pin at A.

Suppose it is desired to draw 5-ft. contours between elevations of 72 ft. and 57.5 ft., the difference of elevation thus being 14.5 ft. The 70-ft. contour will be 2 ft., the 65-ft., 7 ft., and the 60-ft., 12 ft. below 72. Lay a scale between the two points (suppose this distance to be 280 ft.), then swing the straight-edge until it comes to the intersection of the 14.5 ft. and 280 ft. lines as X. From the column "difference of elevation," follow the line at 2 ft. to the straight edge, which gives the distance of the 70-ft. contour from the point 72, and following the lines at 7 ft. and 12 ft., gives the distances of the 65-ft. and 60-ft. contour, respectively, from 72. These distances are plotted while the scale is still between the points, which is probably quicker and more accurate than having to set dividers for each point. W. C. Bunnel.

U. S. Engineer Office, Chicago, Ill., April 10, 1900.

Sir: Referring to Mr. Bedell's letter in Engineering News of March 29, I desire to call your attention to a still simpler method in which there is no need of using dividers.

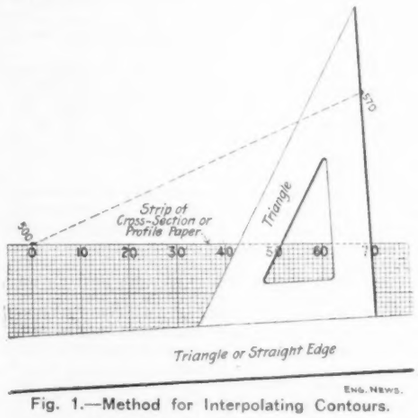


Fig. 1.—Method for Interpolating Contours.

Fig. 1 shows two points with elevations marked, located on a map. A strip of paper with its edge properly divided (cross-section or profile paper) is laid from one point at an angle to the line drawn to connect the two points. Upon this paper is laid a triangle or straight edge and a triangle is placed against this so as to intersect with the upper point and the corresponding division on the strip of paper. By sliding the triangle it is readily seen that it will intersect the line connecting the two points and any intermediate contour can be set off.

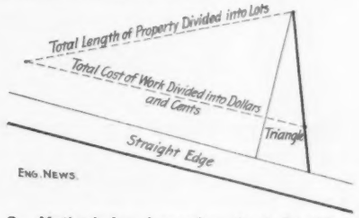

Total Length of Property Divided into Lots
Total Cost of Work Divided into Dollars and Cents
Triangle
Straight Edge
ENG. NEWS.

Fig. 2.—Method for Assessing Cost of Work on Frontage.

As shown by Fig. 2, the method can be used to distribute the cost of work over frontage of property assessed.

I have used these methods for years. They have been described before in other papers, I believe, as I remember reading in 1895 of a description by an English engineer and in 1898 Mr. Emil Neubling, of Pennsylvania, described it. Yours truly, Engineer.

Idaho, April 3, 1900.

Sir: In your issue of March 29 a correspondent gives a method of interpolating contour points. This method is certainly correct within suitable limits, and is much more rapid than some others. But a gain in rapidity would be effected by using a system of vertical lines crossing those shown, in place of dividers and scale as described, for laying off horizontal distances. This would be undesirable, however, as the eyes soon tire in the steady use of such a diagram, and errors are then likely to result from choice of a wrong intersection.

The "interpolater" here shown was designed a year ago, and is intended to secure great speed and accuracy with slight weariness to eye and brain. Its essential feature is a single movable vertical line to replace the system of vertical lines suggested above.

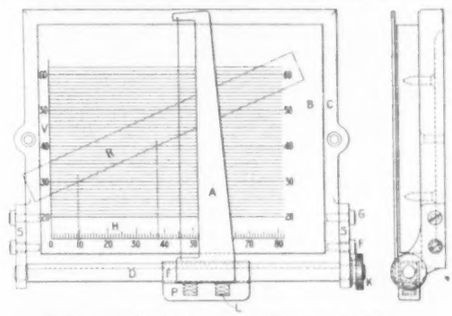
A board B about 4 × 5 ins. is mounted on a brass base C by screws passing through the latter. Two supports S carry a square bar D, on which slides a sleeve E. To this sleeve are brazed an arm A, and a projection P. The arm carries a fine wire W, which is the movable line already mentioned.

To the board is fastened a sheet of paper on which are ruled horizontal lines, the equal distances between them representing successive elevations on the ground. This scale is marked V. A scale of equal parts H is also ruled near the lower edge of the paper. A thin, bevel-edged rule R completes the instrument.

The sketch shows the parts in position for interpolating between two points, which are at elevations 26.5 and 42.8 respectively, and which are 45.5 ft. apart on the map. The arm A is first slid along until W is at 45.5 on H. Then the intersection of W with 42.8 on V is held by a pencil or needle point, and the edge of R is brought to bear upon it, while another point of the edge is passed through 26.5 at the extreme left. Then with R held in place A is slid to the left until W passes through the intersection of 40 of scale V and the edge of R. W is now seen to mark 37.7 on H, showing that the 40-ft. contour point is 37.7 ft. horizontally from the point whose elevation is 26.5. In the same way the 30-ft. contour point is 9.8 ft. distant.

It will be seen that A is raised above the paper far enough to pass above R. If R is of metal, a piece of rough cloth should be fastened with shellac to its under side to prevent slipping.

Values may be assigned to the divisions of V and H to suit the work in hand, these values being indicated in



Instrument for Interpolating Contour Points.

pencil; or several sheets with different scales may be made. The proper height of D with reference to B is secured at F, where the hole in S through which the screw passes is larger than the screw, thus permitting rotation about G. The plane of A is then brought parallel to that of B, and held by the nut K. The proper sliding contact between E and D is secured by cutting out a large slit in the front of E, fitting a plate loosely into it, and pressing the plate against D by spiral springs L.

Very truly yours,
Frank T. Daniels.
No. 1 Mount Vernon St.,
Boston, Mass., April 14, 1900.

(We have also received from Mr. E. E. Greenwood, of Clifton, Arizona, a description of a method substantially the same as that described by Mr. Lund.—Ed.)

The Extent of the Damage to the Water Power Plant at Hannawa Falls, N. Y.

Sir: I have the following to report as to the loss at Hannawa, supplementary to the account published in your issue of April 26: The power house walls were about half completed, and of the finished portion about half will have to be rebuilt, but the material used originally is available for reconstruction. The turbines which were supposed to have been swept away were not in the track of the flood. A large Dayton Globe casing was carried a small distance and deposited into a pocket and covered with earth. It can be used again. With the exception of a hoisting engine, this was the only machinery damaged. The hoisting engine will undoubtedly be used again. There were several large generators of 7,200 K-W., which were fortunately out of the course of the waters.

The loss to the penstocks sections will be small. Some 100 ft. was washed away. Half have already been recovered and the remainder will be found. These can be straightened in rolls.

It will take, perhaps, about 5,000 cu. yds. to repair the walls of the canal, but the haul is short.

Some time after the accident it was noticed that several cubic feet of water had gotten through between the masonry and canal banks on the side of the canal opposite to the break. This matter was investigated by competent parties, and it was found that the earth had contracted from 1-16 to ¼-in. from the masonry, which permitted a seepage and leaking between the earth and masonry. This earth was tamped into place while wet (which is the usual practice) during the summer of 1899. This crack may explain the undermining of the wall.

It is supposed that a similar condition may have existed at the spillway. If this is so the wall opposite the break is just as liable to give way. Contractors claim the accident came at a very good time, believing it would have happened whether gates had been placed at opening or not.

I have seen a number of men who are able to estimate the loss, and the most unfavorable figure is only $18,000 to $20,000, so that the Hannawa Company's estimate of $8,000, considering the material that can be used again, is probably very near the truth.

The work will not be delayed to any extent, I understand from the company, and that 100 additional hands will be immediately set to work. Personally I believe the heavy shock may have been the cause of the earth and masonry having separated on portion of canal opposite break.

Yours truly, John H. Griffith,
Professor of Civil Engineering.
Clarkson School of Technology, Potsdam, N. Y.,
April 28, 1900.

Diagrams for Determining the Weights of Bridge Spans.

Sir: The accompanying diagrams for determining quickly the weight per lineal foot of plate girders and trusses for bridges were made by me for use in the engineering department of the Boston Bridge Works. I use them in estimating bridge work in all cases where sizes

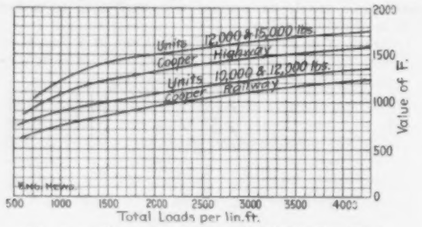


Fig. 1.—Diagram Showing Weight Per Foot For Plate Girders Determined from 163 Separate Cases.

$$\left[W = \frac{\text{Span} \times \text{total load per foot}}{F \text{ (taken from curves.)}} \right]$$

are not required. Even where sizes are required, the curves are a useful check on figured weights. As these curves have been determined from a large number of actual cases selected from past estimates, they may be taken as correct. The time required to find the weight of a bridge truss by first determining the stresses and sizes, may require an hour or more, depending on the length of span, while from my curves the weight can be found in a very few minutes.

There have been many formulas developed from time to time, to represent the weights of trusses and bridges, but

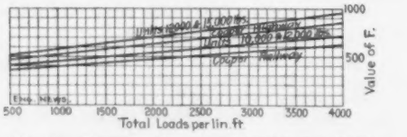


Fig. 2.—Diagram Showing Weight Per Foot Of Trusses Determined from 418 Separate Cases.

$$\left[W = \frac{\text{Span} \times \text{total load per foot}}{F \text{ (taken from curves.)}} \right]$$

curves are more easily used. It will be noticed that the loads include both dead and live, per lineal foot of truss. In the case of wheel loads the equivalent uniform may be used. The curves apply to either pin-connected or riveted trusses, with inclined end posts. For spans of over 180 ft. the top chord will be curved, and sub-panels used.

Very truly yours, H. G. Tyrrell,
Assistant Engineer, Boston Bridge Works.
Boston, Mass., April 21, 1900.

The Failure of the Austin Dam.

Sir: In an article upon dam construction in your issue of Nov. 16, 1899, I pointed out the fact that too low a margin of surplus strength is given to dams. The factor of safety of 2 to 3 is not sufficient to cover all the changing conditions that occur in connection with a dam.

In my article referred to above, I claimed that a dam was subjected to greater pressure at the center of the stream than at the ends, and I also showed wherein a dam was weaker at the center than towards the ends. The drawing together of these two factors makes a condition that is likely to wipe out the small factor of safety that the dam is supposed to have.

I am also sure that by observing the conditions as they exist, and building in a way to provide for them, a structure can be erected that will have a safety factor of 6 instead of 2, and at the same time not increase the cost by more than 20%. One of these conditions is the fact that a dam is subject to moving loads and unequal loads.

It is a well known but little regarded fact, that a stream runs much faster at the center than it does at the sides. The center of the river is always lower than at the sides, consequently all debris has a tendency to keep to the center, thus the center of the dam gets all of this pounding during flood time.

These two factors increased velocity of water and undue share of impact from debris, must tend to overload a dam at the center, or point of greatest velocity of water. This point may be called the center, but it may not be by actual measurement in the mid-channel between the abutments of the dam, but it will be subject to the nature of the bed of the stream, banks and so forth, and may vary with the varying height of the flood.

In the case of the Austin dam, this center has evidently been at B, as shown by Prof. Taylor in Fig. 4 of your issue of April 19. Fig. 5 tends to confirm this by showing the debris passing over that portion. (The two views mentioned will be found repeated in this issue in the further article by Professor Taylor on the failure of the dam.—Ed.)

It is likely that previous floods have also had their center near B, and have weakened it.

Now, K-C and A-H, not being so hard pressed by the current, have acted as abutments to the portion C - A, and all portions of the structure yielding under pressure, in proportion to that pressure, and B being subjected to the greatest pressure has yielded the most, and the top of the dam, C-A, just before failure, must have been a curve, with a reverse curve at C and at A.

Instantly upon the failure of B, the pressure and rush of water at this point has acted with a lever arm C-B, to break C-B away from K-C. This is clearly shown from the fact that B' is farther down stream than C' or A'.

The same thing has occurred in regard to B-A, only from the sketch we may infer that it resisted more on account of being so close to H-G.

To my mind, this is an exceedingly clear illustration of the fact that the shore ends of the structure are strengthened by their connection to the banks, and the center portions are weakened by the rush of water and debris against them.

Under these conditions, with no provision made for taking care of unequal loads, the structure has actually been divided against itself, and could only be saved by having a large safety factor at its strong portion, which would evaluate a safety factor of some sort at its weakest part. This, it evidently did not possess.

The discussion of the responsibility for the Austin dam failure can do no good. The individuals are not blameworthy. It is the system that is at fault, and the same system prevails everywhere, and until a radical change is made in the methods of computing pressures on a dam, and of providing for such pressures, the same thing that has happened at Austin will occur in other places.

Yours truly, Jno. S. Fielding.
913 Rebecca Ave., Pittsburg, Pa., April 25, 1900.

Notes and Queries.

M. R. E., Easton, Pa., states that the last annual report of the New York Central & Hudson River R. R. Co. refers to "10-wheel mogul freight locomotives," and inquires whether it is correct to call a 10-wheel engine a mogul. We know of no authority for such usage. The term mogul should be restricted to a locomotive with six drivers and a two-wheel leading truck.

MORE LIGHT ON THE FAILURE OF THE AUSTIN DAM

By Thomas U. Taylor, Assoc. M. Am. Soc. C. E.*

In the issues of the Engineering News of April 12 and 19 the failure of the Austin dam was fully set forth and described. At the time of the accounts on the above dates the water had not reached a sufficiently low level to show exactly how much of the broken section had been taken out. The indications were to the effect that the

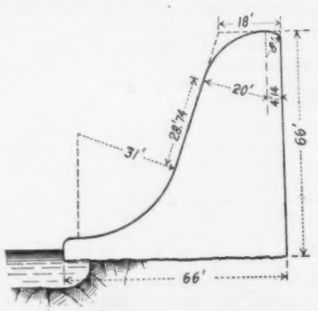


Fig. 1.—Sketch Showing Undermining of Toe of Austin Dam.

whole section, foundation and all, was pushed down stream.

Before discussing the causes of the break, I desire to call attention to the letter (see Eng. News, April 19, 1900) that Mr. Joseph P. Frizell wrote on April 8, 1896, stating that at about 300 to 400 ft." from the east end of the dam, a very friable condition of limestone was encountered, and indicating that the discharge of the tail-race waters along the toe of the dam was liable to have an abrasive action on the foundations under the toe. Mr. Frizell also stated that it was his intention, had he continued in charge of the work, to have executed some supplementary work of protection for the bed of the river just below the

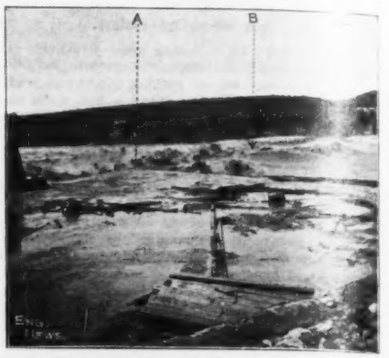


Fig. 2.—View of Break from East End, Looking Down Stream, Three Minutes After Failure.
(Repeated from our issue of April 19.)

toe. This supplementary work would probably have consisted of a cement apron about 100 ft. wide, at least 1 ft. thick, and several hundred feet long. We must recall to mind the fact that Mr. Frizell's plans contemplated the discharge of the tail-race waters into the channel of the river several hundred feet below the dam, so that the tail-race waters would have had no effect on the toe foundation.

The waters of the tail-race followed the toe of the dam fully 600 ft., and were discharged through a narrow neck 45 ft. wide and (when the water was not flowing over the dam) of an average depth of 2.8 ft. during the day and about 3 ft. at night, when the full power was on. Between this narrow neck and the power house, the writer, with Mr. H. K. Seltzer, made soundings along the toe of the dam in March, 1899. At or near the point of breaking we failed to reach bottom with a pole 5.3 ft. long, even when the hand holding it was thrust at least 2 ft. below the surface of the tail-race water. This surface was at that time 2.5 ft. below the toe of the dam. This makes the bottom of the tail-race more than 9.5 ft. below the toe of the dam at this point. Several soundings of this kind were made along the toe. The tail-race near the dam passed over a shoal-like formation and entered the tail-race pond at about 50 ft. from the power house wall. Between this point and the narrow neck alluded to, the tail-race was bounded by the toe of the dam and a curved shore line. Its maximum width was about 150 ft. and its narrowest (at the neck) 45 ft. In March, 1899, simultaneous discharge measurements were made at this narrow neck and in the fore-bay (when the lake level was over 10 ft. below the crest of the dam); and while the flow through the tail-race was greater than that into the penstocks through the fore-bay, the difference was not larger than could be accounted for by the "spring" and the fluctuations of the flow caused by increased demands in the street car service.

The limestone formation in the vicinity of the dam consists of alternately hard and soft strata. The outcroppings in Bee Creek (just above the dam), at Taylor's lime chute (about a half mile above the dam), and that through which the excavation was made to repair the headgate masonry, are all of such formations. The soft strata could be handled without a pick and often with a shovel, but the hard was composed of a fairly good quality of limestone. The dam rested on one of these hard strata in its western part. During a freshet in 1892, the overfall cut through this hard strata, tore up large pieces (some of which would average 10 ft. long, 4 ft. wide and 2.5 ft. thick and weighing 7 to 8 tons) and deposited a whole quarry in a confused and irregular pile

*Professor of Civil Engineering, University of Texas, Austin, Tex.

about 150 to 200 yds. further down the river. These stones remained in this location till the big freshet of June 7, 1899, when they were carried away.

The above facts are necessary for a proper understanding of what follows. In 1897, Mr. J. G. Pinson, one of Austin's leading citizens, and a cashier in the oldest National bank in the city, while fishing along the toe of the dam, ran his fishing

Fig. 3.—View of Dam Five Minutes Before the Failure.

pole under the toe of the dam 8 ft. This shows conclusively that either the water flowing along the tail-race scoured out the foundation under the toe of the dam, or the over-falling water had undermined the toe. A large percentage of the water flowing over the east half of the dam at ordinary heights re-enforced the tail-race waters and produced a strong current right along the toe of the dam for over half its length. It has now been proven by actual measurements that the toe was cut under at some places, as shown in Fig. 1. Mr. Palm, in speaking to me about it, said that he often wondered why the toe did not break off. This left the dam a prey to the pressure of the water and it was only a question of which was the greater force, that of the water or the friction between the dam and its partially destroyed bed.

In your issue of April 26, your correspondent, "M. Am. Soc. M. E.," misinterprets Fig. 5 of your issue of April 19 (reproduced here as Fig. 2). This snap shot taken three minutes after the dam broke shows two barrels and other debris (planks, scantling, etc.). The derrick-like tower formed an anchor for the fore-bay boom log and the platform by it is the boathouse platform. But these (except platform) were not stranded as your correspondent concluded, but were floating in water 16 ft. deep. This debris (barrels and all) came from the boathouse, which was located about 200 ft. from the dam, and which collapsed about one

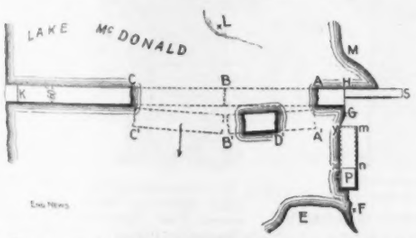


Fig. 4.—Sketch Plan Showing Break in the Austin Dam, April 7, 1900.
(Repeated from our issue of April 19.)

minute before the snap shot was taken. The water on the crest of the dam between the bulkhead and point A, Fig. 2, was 3.5 ft. deep.

Some interpretations of the failure have been based on the amount of silt in the lake immediately in front of the dam. While the average depth of the water (area of cross-section divided by breadth of lake) was 27 ft., the depth in the original channel was 38 ft., leaving 30 ft. of silt But it must be kept in mind that the dam did not break in the main channel. The western part of the dam now standing covers nearly all of the old channel. The silt was a fine gritless stuff (almost ooze), into which the writer has repeatedly thrust an oar with moderate pressure fully 3 ft. When dipped up and turned out on a platform it would gradually settle down into a flat sheet or cake whose upper surface would assume an almost horizontal position. When the break occurred the silt that was in contact with the dam would have flowed out had there been no water; but with a torrent 41 ft. deep flowing over it in a cataract with an immense velocity it was cut away with such swiftness that in three hours the plateau on the east side of the lake, where there was an average depth of 16 ft. of water below the crest of the dam, was swept almost clean of silt. A slight amount of it remained, as can be seen in Fig. 6. A week after the break the writer tramped a few miles along the shores, and everywhere this silt in the main channel was cut into fantastic shapes by the currents of the river and by side streams. It reminded one of the Bad Lands of Dakota.

Many correspondents have laid great stress on the drift. Fig. 3 is a small snap shot taken by Mr. Pinson five minutes before the break, from a point below E, Fig. 4. This shows that there was only a small amount of drift, and that was passing over a part of the dam that did not fail It was Mr. Pinson's kodak that furnished us with Fig. 5 of April 19 (the present Fig. 2), and also with Fig. 5 of this issue, taken ten minutes after the dam broke. The parts can readily be identified by comparing with Figs. 2 and 4.

The Outlook.

It is the unanimous opinion of the water and light commission that the dam should be rebuilt. On April 9 they passed the following resolutions:

(3) That in our opinion a steam engine and boilers should at once be secured and connected with the pumps in the pumping station (two miles below dam), and the

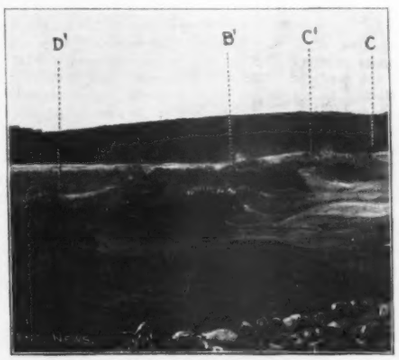


Fig. 5.—View of Break Looking Down Stream, Ten Minutes After Failure.

pumping of water to the city and its citizens resumed at the earliest moment practicable.

(4) That steps should be immediately taken to rebuild the dam and power house upon better and securer plans, and to reconstruct the headgate masonry by securing it and its foundations against leaks and possible openings, and by lowering the penstocks to provide against a scarcity of water in time of drouth.

(5) That to accomplish these purposes we invite the co-operation of the city council and the citizens of Austin, and also of the holders of the bonds issued for the construction of the dam.

(6) That to carry out these purposes we are of the opinion that the city and citizens should be content to let the bonded indebtedness of the city for the construction of the plant remain as it now is and pay the interest on it regularly as it falls due, as soon as satisfactory understanding can be had with bondholders, and the holders of the bonds should be willing to furnish the amount of money necessary to repair the damage done to the plant and place it in good condition.

The commission then apointed a committee of 16 leading business men to secure an expression of the opinion of our citizens.

There are three possible solutions to the problem of water and lights that are being seriously discussed:

(1) Rebuild the dam; (2) sell out to the old company (The Austin Water, Light & Power Co.); (3) build a steam plant and either buy out or ignore the old company. These questions will be considered in their order:

(1) To rebuild the dam and carry out the resolutions of April 9, passed by the Water and Light Commission, will cost at least one-half million dollars. (This can be approximately itemized as follows:

(a) Rebuild the broken part of dam	$300,000
(b) Replace headgate masonry	100,000
(c) Replace power house	50,000
(d) Reinforce present dam	25,000
(e) Reinforcing toe	25,000
Total	$500,000

There is no possibility of raising this amount by new bonds, for the simple reason that the city is loaded up to the guards now. The taxable values, even at the present high rate of assessment,

Fig. 6.—View Showing Remains of Silt Near Dam.
(The men are standing on the original soil; the silt appears just behind them.)

would not justify the issuance of over one-tenth of this amount. The bonded debt of the city at present is:

Ante-dam bonds	$125,000
Water and light bonds	1,492,000
High school bonds	50,000
Total	$1,667,000

The taxable wealth is about $11,000,000.

The only other recourse then is to resort to the bondholders. The city has been paying in the last few years about $80,000 per annum interest on the water and light bonds. Practically all of this has been paid by taxes, as nearly all of the earnings of the plant were utilized in operating expenses, extensions and repairs. The bondholders would have to pay out $500,000 to strengthen their present bonds, or give the city what is equivalent to seven years' interest. If they do not rebuild the dam, it takes the dam out of the realms of probability; but if they do not, taxable values will certainly shrink. The highest allowable tax rate of 2.5% would not produce over $200,000, and the present running expenses of the city are over $140,000 per annum.

(2) There is an almost unanimous opposition to selling out to the old company.

(3) To equip a steam plant of a capacity equal to that of the plant destroyed (about 1,000 average HP.) would cost, as estimated by Mr. H. C. Patterson, Superintendent of Water and Lights, $250,000. To raise this amount it is proposed (a) to sell copper wire not needed for $50,000; (b) to get the bondholders to remit the interest for the current year, $80,000; (c) to get the bondholders to accept 2% interest instead of 5% for the next two years, i. e., to remit 3%, or $96,000.

The operating expenses of the steam plant will be about the same as those of the plant destroyed, with the exception of coal, which will probably cost $30,000. This solution also contemplates the acceptance by the bondholders of 3% permanent interest on the bonds after three years; the 2% saved ($32,000) would cover the item of coal and wood. It has also been suggested that the interest on the bonds be scaled at once to 2½% permanently.

The first and third solutions contemplate material assistance from the bondholders. The first solution would involve an expenditure on their part of $500,000 at least. Thus the bondholders would be out of pocket at least $2,000,000, but would get $80,000 in interest, or 4% on their outlay, but the half million would not be returned. The third solution involves their paying $176,000 in three years and accepting after that $78,000 per year, or less than 3%.

PROGRESS OF THE METRIC SYSTEM IN THE UNITED STATES.*

In conducting the investigations necessary for this report, the fact was early made apparent that the use of the metric system in commercial lines in the United States seemed to be confined to comparatively few and isolated cases of manufacturing companies, engaged in the export of their products to foreign countries, wherein the metric system prevails; such being the case, your Committee has not attempted to locate and report upon all of such cases, nor to specify them particularly. This fact has made it necessary to make this report much more general than might have been desired or expected. The use of the metric system in the United States was legalized by Congress in 1866. It was provided thereby that the use of the metric system in all contracts, etc., did not render such invalid, and thereby made the use of it optional and legal, but not compulsory. Various legislative and committee work has since been done in response to memorials presented to Congress by different associations and scientific societies throughout the United States.

In December, 1895, a bill was introduced into the House of Representatives by Mr. Hurley, which was referred to the Committee. At the first session of Congress in 1898 Mr. Hurley again introduced a bill to fix the standard of weights and measures by the adoption of the metric system. This was referred to the Committee on Coinage, Weights and Measures, since which time nothing definite has been done with it. The bill previously introduced by Mr. Hurley did not make the use of the metric system compulsory upon the people, but simply established it as a legal standard to which reference could be made in cases of dispute, or for any other proper purposes. On March 16, 1896, a bill was introduced into Congress, providing as follows:

(1) From and after July 1, 1898, all departments of the United States Government, in the transaction of all business requiring the use of weights and measurements, except in completing surveys of public lands, shall employ and use only the weights and measures of the metric system.

(2) From and after Jan. 1, 1901, the metric system of weights and measures shall be the only legal system of weights and measures in the United States.

The bill was debated April 7, 1896, recommended April 8 to the same committee, to be brought forward in the 1897 session. Nothing further has thus far resulted from this move.

Your Committee finds that there has been no legislation in any of the states regarding the use of the metric system, except in a few cases which provide that the metric system may be employed, and that no contract shall be invalid because of its use therein, covering practically the same ground covered by the United States Congress when legalizing the system in 1866. In the work of the Smithsonian Institution the metric system is used almost exclusively.

In the different departments of the U. S. Government at Washington the metric system is used as follows: In the Department of the Coast and Geodetic Survey the metric system is used exclusively in their computations. Their charts, while they show soundings in feet, show also a metric scale, by the use of which the different dimensions shown in feet may be readily transformed into metric measurements. In the Agricultural Department all scientific work in chemistry, etc., is done by the use of the metric system. The extensive natural history work in this department is also carried on with the use of the metric system exclusively for its calculations. The Post Office Department uses it in connection with foreign metric countries, but not in any work applying to our own country exclusively. In the Department of the Surgeon-General of the Army their contracts for medical supplies all embody the metric system, and their supply table (page 82, Manual of 1899) shows all supplies as being packed in metric packages. All of the army post physicians and apothecaries are required to use the metric system in making and filling prescriptions. The Department of the Surgeon-General of the Navy also uses the metric system in much the same way as that department of the army, and manufactures its own bottles and packages in accordance with metric measures. When supplies are purchased for the Navy Department in the original packages, these supplies are repacked in the metric packages furnished by the Navy Department. Article 670, Regulations for the United States Marine Hospital Service, 1897, reads as follows: "Officers shall, for all official, medical and pharmaceutical purposes, make use of the metric system of weights and measures. In expressing quantities by weight, the term 'gram and centigram,' and in expressing quantities by measure, the term 'cubic centimeter' only shall be employed." In Porto Rico and Cuba the metric system has been and is exclusively in use in all official and domestic work; the natives and residents of those countries being familiar with no other system.

Manufacturers of measuring implements, gages, instruments of precision and draftman's supplies make metric instruments for such uses. A few manufacturers of fire-arms, screw threads, screw cutting lathes, manufacture machinery in metric dimensions for export to foreign countries, but not for use in the United States. A Philadelphia firm and a New York firm make injectors to the metric scale; a Massachusetts and Rhode Island firm make drills and gages; one of the largest scale manufacturing companies manufactures metric scales, and one of the largest watch manufacturing concerns in our country has used metric measures since 1869. Of the large steel companies, none use the metric system, except when called for by foreign export trade. The system is used almost entirely in the manufacturing of electrical goods, and one refrigerator manufacturing company uses the metric system in everything that it manufactures, except fittings.

The Solvay Process Co., of Syracuse, N. Y., manufacturing soda ash and bi-carbonate of soda, uses the metric system in every possible way in its extensive works. It is not used for lineal measurements. All quantities or sub-division of coal or other supplies; the measurements of liquors or water; the calculation of heat units, and the measures of temperatures are all specified under the metric system. The drawings to go outside of their works for construction, etc., are not made in the metric system. The metric system is exclusively used in the laboratory and in all chemical work. A number of other isolated cases have been brought to the attention of your Committee wherein the metric system is in use by individual manufacturing concerns, but it is not thought necessary to detail them, as they are comparatively few. Prominent manufacturers of astronomical and physical instruments use the metric system in their measurements of parts to replace other parts in instruments of precision, where such instruments of precision have been manufactured in metric countries. In electrical engineering and experiments the metric system is almost exclusively used.

As the result of the investigations that your Committee has been able to make, its conclusion is, that thus far, the introduction of the metric system in ordinary commercial lines of the United States, has been very gradual and generally confined to cases in which manufacturing concerns export to metric countries, machinery made by metric scales, for use in such countries. Except as herein noted, your Committee is unable to find that the system is being introduced into this country to any considerable extent, in the way of supplanting our present system of weights and measures, for our own use. The theoretical study of the metric system is made a part of the course of instruction given in our schools, colleges and universities.

*Abstract of the report of the Committee on the Metric System, presented at the Chicago meeting of the American Railway Association, April 25.

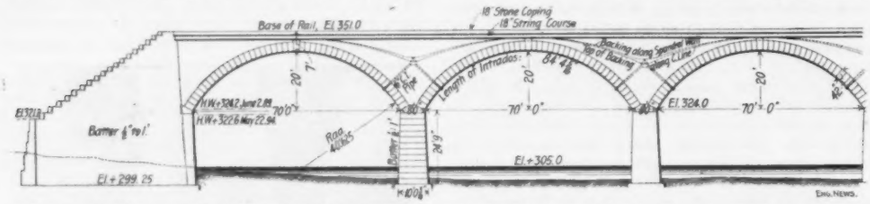


FIG. 1.—PART SIDE ELEVATION OF 3,820-FT. STONE ARCH BRIDGE FOR THE PENNSYLVANIA R. R. AT ROCKVILLE, PA.

Wm. H. Brown, Chief Engineer, Pennsylvania R. R.
Drake & Stratton and H. S. Kerbaugh, Philadelphia, Pa., Contractors.

THE 3,820-FT. STONE ARCH BRIDGE FOR THE PENNSYLVANIA R. R., AT ROCKVILLE, PA.

We illustrate in the accompanying engravings the general details of the longest stone arch railway bridge in the world. Briefly described this bridge will consist of 48 spans of 70 ft. each and will be 3,820 ft. long, including the aggregate widths of the piers. The new bridge will cross the Susquehanna River at Rockville, Pa., about five miles above Harrisburg, Pa. It will be located a short distance below the present Pennsylvania R. R. double-track bridge, consisting of 23 spans of about 160 ft. c. to c. of piers, and will provide for four railway tracks. The contract for constructing the east half of the bridge has been let to Drake & Stratton, of Philadelphia, Pa., and that for constructing the west half has been let to H. S. Kerbaugh, of Philadelphia, Pa. It is expected to have the construction completed in two years.

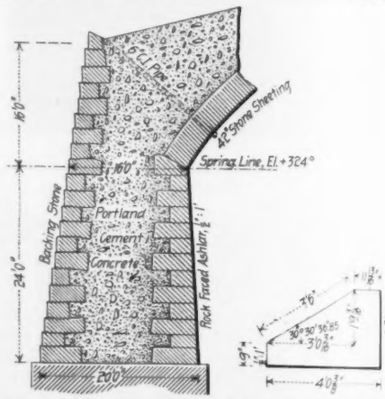


Fig. 3.—Transverse Section Showing Abutment Masonry, Rockville Bridge.

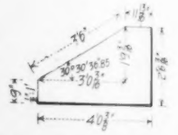


Fig. 2.—Details of Skewback Stones for Rockville Bridge.

The great length of the new Rockville Bridge as compared with its other dimensions makes it out of the question to present a satisfactory illustration of the whole structure in elevation. As, however, the arch and pier construction is exactly the same throughout, except at five points where special abutment piers are used, the elevation of the three spans at the west end, which is shown by Fig. 1, will serve to give our readers an adequate understanding of its general appearance. The arches are all of 70-ft. span, with a rise of 20 ft. and a thickness of ring of 4.2 ins. The arch ring is 91 ft. 7 7-16 ins. long on the extrados and 84 ft. 4 5-16 ins. long on the intrados. The regular ring stones are 1 ft. 11 1-16 ins. on the extrados and 1 ft. 9 7-32 ins. on the intrados. There are 46 stones in each ring besides the keystone, which is 2 ft. 2 11-16 ins. on the extrados and 2 ft. ¼-in. on the intrados. The mortar joints.

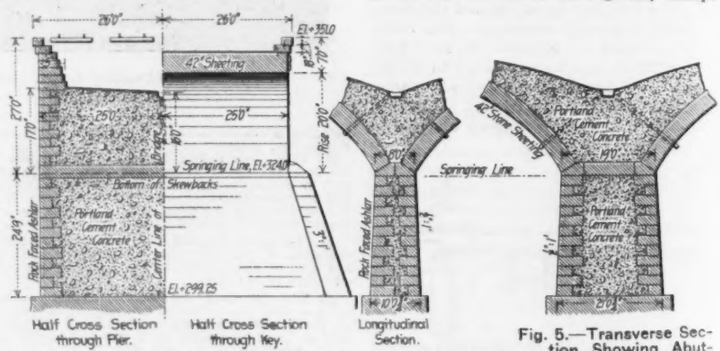


FIG. 4.—SECTIONS SHOWING REGULAR PIER MASONRY, ROCKVILLE BRIDGE.

Fig. 5.—Transverse Section Showing Abutment Pier Masonry, Rockville Bridge.

48 in number, are all ¼-in. thick. The dimensions of the skewback stones are given by Fig. 2. Figs. 3, 4 and 5 show details of the abutment, pier and arch construction.

The backing for the arch rings is Portland cement concrete and has its top surface dished transversely of the bridge, so as to facilitate drainage to the valleys over the piers. The spandrel filling above the backing is ballast on which the four lines of railway tracks are laid in the ordinary manner. The spandrel walls are rock-faced ashlar masonry and they are surmounted by a cornice consisting of 18-in. string courses and copings projecting outside the planes of the spandrel walls, as shown by Fig. 4. The total width of the bridge between the outside edges of the coping courses is 52 ft.

Two styles of piers are employed to carry the arches. Five abutment piers of the cross-section shown by Fig. 5 divide the 48 arches into six sections of eight arches each. Between the abutment piers the arches are carried by thinner piers of the construction shown by Fig. 4. Both forms of piers are generally rectangular in plan, with a V-shaped ice breaker on the upstream end. The face walls are of rock-faced ashlar masonry and the backing is of concrete. Exactly the same type of construction is employed for the abutment masonry, as is shown by Fig. 3.

In plan the bridge maintains the standard width of 52 ft. at coping level throughout its whole length, except for the three spans nearest the west end, where the north spandrel wall curves northward as the abutment is approached until the width attained is 68 ft. at the springing line or 70 ft. at the coping level. This modification is made to provide for the curve to the north which the railway line takes on the west side of the river. As the bridge is designed the base of rail will be 46 ft. above the surface of the water at ordinary stage. The springing line level was placed at nearly the same elevation as the great flood of June 2, 1889, thus ensuring ample waterway under all probable conditions. For the other details of the construction the reader is referred to the drawings Figs. 1 to 5, inclusive.

The plans for this bridge were prepared in the Engineering Department of the Pennsylvania R. R., by Mr. H. S. Righter, under the direction of Mr. Wm. H. Brown, Chief Engineer. The construction work will be supervised by Mr. H. S. Righter and Mr. Geo. Nauman, Assistant Engineers.

UNION STATION AND GENERAL OFFICE BUILDING FOR THE PENNSYLVANIA R. R., AT PITTSBURG, PA.
D. H. Burnham & Co., Chicago, Ill., Architects.

NEW UNION STATION FOR THE PENNSYLVANIA R. R., AT PITTSBURG, PA.

The accompanying drawing shows the design adopted by the Pennsylvania R. R. Co. for its new union station and general office building at Pittsburg, Pa. The building is 175 × 352 ft. in plan, and was designed by D. H. Burnham & Co., Architects, of Chicago, Ill. Briefly described, the ground floor will be occupied by the Adams express and the baggage rooms, U. S. mail rooms, and the kitchen for the restaurant. There will be a depressed wagon way from Grant St. into this lower floor for baggage and express wagons, and also an opening from Liberty St. The train floor will comprise the waiting room, dining room, restaurant and the usual toilet and smoking rooms, and have a high ceiling and be quite ornamental. The approaches to the waiting room will be by an inclined drive for cabs from Grant St. to the level of the train floor, which will be about 14 ft. above the present floor, and the tracks in the train shed will be elevated in order to bring them to the same level.

Above the waiting room will be ten stories for offices, to be occupied by the Superintendent of the Pittsburg Division and the Division Freight Agents of the main line; the Allegheny Valley Ry. Co.'s general office, including Superintendent and Auditor's Department, and the General Offices of the Pennsylvania Co.'s Lines, west of Pittsburg. The tracks leading to the Pittsburg, Fort Wayne & Chicago R. R., which now crosses Liberty St., at grade, will be elevated so as to give not less than 14 ft. of clearance for street cars and ordinary street traffic. This elevation will be continued to the west side of the Allegheny River, so as to avoid all grade crossings in the city of Pittsburg. We are indebted to Mr. Wm. H. Brown, Chief Engineer Pennsylvania R. R., for the information from which this description has been prepared.

ACCIDENT TO THE VAN BUREN STREET BRIDGE, CHICAGO.

An accident to the Scherzer bascule bridge over the Chicago River, at Van Buren St., occurred on May 2. The bridge had been raised to let a vessel pass, when the east leaf broke away from the operating strut and fell to the closed position, crashing down upon the vessel. Each leaf is supposed to be counterbalanced to stand normally at an inclination of about 45° above the horizontal, and it was reported that some of the counterweights had been removed, thus throwing additional strain on the connection with the operating strut and permitting the leaf to fall when this connection broke. Nobody was hurt.

An investigation shows that the steel casting on the end of the operating strut, which carries the pin attaching the strut to the center truss, broke short off just behind the boss in which the bearing for the pin is formed. The fracture disclosed a very large blow hole in the metal, a fissure from which extends nearly to the outside of the casting, in the fillet between the web and the boss.

The casting referred to has two bosses with bearings for pins, connected by a vertical web, while another web projects beyond the outer boss; the detailed construction may be seen by reference to the illustrations of this bridge in our issue of Feb. 21, 1895. The casting which failed is shown in Fig. 5 on the inset sheet in that number. The center boss carries the pin in the top chord of the truss, and the rear boss carries the pin at the end of the operating strut, while the outer web is the pin which operates the lock. This style of connection is not used in the later Scherzer bridges, the casting being dispensed with.

This was the first bascule bridge of the Scherzer type, and was built in 1895, under the direction of Mr. Samuel G. Artingstall, M. Am. Soc. C. E., City Engineer, and Mr. W. R. Roberts, City Bridge Engineer. The contract for the superstructure was first let to Mr. A. Gottlieb, but after his death it was relet to Mr. C. L. Strobel, who had the structural work manufactured by the Elmira Bridge Co., of Elmira, N. Y., and the machinery built by the Scaife Foundry & Machine Co., of Pittsburg, Pa.

According to the best information obtainable, the accident was caused primarily by the defective casting, but the fracture of this followed a failure of or improper handling of the brakes. When the bridge was raised to its full height, the bridge tender applied the air brakes, but these refused to work in the beginning, and as a consequence the man applied the hand brakes. These, however, were insufficient to check the bridge in its downward course, owing to the momentum it had gained. The air brakes then suddenly got into action, and the sudden shock caused thereby was sufficient to break the defective cast-steel knuckle joint, the fracture showing a blow-hole amounting to from 18 to 20% of the total cross-section of the joint. Of course, the bridge continued downward, but the speed was checked by the jerk from the operating strut, and it consequently stopped before reaching its lowest position.

With reference to the alleged removal of counterweights, noted above, Mr. Scherzer, the President of the Scherzer Bridge Co., asserts that some of the counterweights had been removed. The city authorities deny this, however, and state that the dampness of the floor, and the addition at one time made by the street railway company to carry its trolley wires, have made the bridge a little heavier on the river arm than the counterweight. In any event it is claimed that the proper operation of the bridge depends not so much upon the exact counterweighting of the bridge as upon the way in which the machinery handles it.

The present condition of the bridge is said to be as good as it has been for the last three or four years, with the exception that the piers on the west side have settled, owing to the excavation of the by-pass between the abutments and the front pier; thereby disturbing the conditions of the heel lock. On account of dredging in the river by the Sanitary District, the air pipe and all the electrical cables transferring electricity from one

side of the river to the other in case one power house is broken down, have been removed, and this makes it somewhat difficult at times to handle the bridge. The bridge broke down at 9.25 a. m. on May 2, and was repaired by 3 a. m. of May 4.

THE REASON AND A REMEDY FOR THE DISAPPEARANCE OF TELESCOPE CROSS-WIRES.

By J. C. L. Fish.*

Students of surveying are often troubled, when observing an object through the telescope of a transit or level, by the fading of the cross-wires. It is the object of this paper to make plain the cause of this trouble and show how it can be prevented.

The objective forms within the telescope the image of an object which lies without. The distance from the objective to the image depends on the distance between object and objective. If the object is at first 20 ft. from the objective, and this distance be increased to 20 miles, the image will move toward the objective by only about 1 in.

The cross-wires are fixed in the tube at a point such that, by moving the objective in or out, the image can be brought to their plane, provided the object be not less than about 20 ft. from the objective. If the objective be run out till the image comes precisely into the plane of the cross-wires, the image and the wires must be at exactly the same distance from the eye; and therefore the eye, when adjusted to see one most distinctly, must be in adjustment to see the other most distinctly. Thus when the attention is transferred from the wires to the image the former cannot fade.

If, however, the image lies before or beyond the wires, the eye, when focussed to see one distinctly, is not in condition to see the other distinctly. The eye can adjust itself to see either plainly, but it cannot be brought to see both plainly at the same time.

The eye-piece serves only as a magnifying glass with which to see the image better; and what is said above is equally true when the eye-piece is placed between the eye and the image.

The following simple experiments may serve to make plainer the above statements: (1) Look through a screened window at a landscape. Though the bars of the screen are kept in mind, they are scarcely seen. Transfer the gaze to the bars of the screen. As soon as the eye is readjusted for the shorter distance the bars become distinct, while the landscape fades. (2) Return the gaze to the landscape. The eye changes focus; the bars fade; and the landscape becomes again distinct. It will be noticed that the eye readjusts itself more easily and quickly for the landscape (which is large) than for the bars of the screen (which are small).

After a little practice the eye can be kept in an adjustment proper for an intermediate distance, when the screen and the landscape will appear to be equally distinct, but both much blurred.

The same thing occurs on looking into the telescope, when the image and the wires are not in the same plane, i. e., when both are not perfectly distinct. This is because the eye becomes focussed for a point midway between the image and the wires, when both are seen, though indistinctly. The observer changes the focus of his eye to see the image more distinctly and the wires fade partially or entirely.

(3) Look at the hand held between the eye and the screen. Transfer the gaze to some object in the landscape. The eye, in changing its focus for the new distance, focuses for every intermediate distance; and the focus at some instant is just right for the intermediate distance of the screen, which for that instant becomes distinct.

To avoid the fading of the wires it is then only necessary to insure that the image is in the plane of the wires when making an observation. To do this proceed as follows: Direct the telescope toward the sky, and move the eye-piece in and out till the wires appear as distinct as possible. (This is the adjustment for parallax usually given.)

When about to make an observation, direct the telescope toward the object to be observed, and, keeping the gaze directed at the cross-wires,† move the objective in and out till the image appears to be as distinct as the wires.

The image ought now to be precisely in the plane of the wires, but owing to poor judgment the image may be taken to be as distinct as the wires when it is not. In this case there will probably be some fading of the wires when the gaze is turned to the details of the object.

If such is the case, move the eye about within the limits of the eye-piece opening. This motion will produce an apparent movement of the wires over the object, for the two are not precisely in the same plane. While moving the eye thus, very slowly move the objective in and out (through a very short amplitude) until this apparent movement of the wires becomes zero. The image is now precisely in the plane of the wires.

If an observation be made on a leveling rod while the rod and wires are not both at once perfectly distinct (i. e., while the image of the rod is not precisely in the plane of the wires), the rod reading will vary with the position of the eye at the eye-piece. This accounts for the fact that students, though using a well-adjusted level, equal back and fore sights and a good rodman, find it sometimes impossible to make their levels "check," even between closely adjacent bench-marks.

*Palo Alto, Cal.
†This direction is given in Raymond's "Surveying."

BOOK REVIEWS.

MECHANICAL ENGINEERS' POCKET-BOOK FOR 1900.—Edited by William H. Fowler, Wh. Sc., M. I. Mech. E., M. Iron & Steel Inst. Manchester: The Scientific Publishing Co. New York: D. Van Nostrand Co. Leather; 4 x 6 ins.; pp. 499; tables and illustrations; $1.00.

There are several new features about the hand-book under consideration. First, it is issued yearly, making it possible to keep the information thoroughly up to date. Secondly, because of the large number of advertisements inserted, it is possible to sell the book at what seems to be a comparatively low price considering the amount of material given and the mechanical make-up. The advertising pages are not inserted between the reading pages. In regard to the first point, we note that the portions relating to electrical engineering, high steam-pressures, machine tools, textile machinery, refuse destructors and gas engines are especially good. The usually unsatisfactory treatment of mathematics and mechanics found in most hand-books is omitted, but many mathematical tables are given. There is a similar absence of definitions of elementary terms. On the other hand, there is a great abundance of information upon live engineering topics. The book is suited for the use of the practicing engineer, rather than that of the student. We can suggest only an enlargement of the work along its present lines.

POWER TRANSMITTED BY ELECTRICITY AND APPLIED BY THE ELECTRIC MOTOR.—By Philip Atkinson, Ph. D. Second edition, revised and new matter added. New York: D. Van Nostrand Co. Cloth; 5 x 7½ ins.; pp. 241; 94 illustrations. $2.00.

The first edition of this book was published under the title, "The Electric Transformation of Power." In the present edition new matter and illustrations have been added relating to developments in the electrical field during the last five years. The book is intended for non-technical readers and is by no means free from the incorrect and loose statements in which books of this class usually abound.

It is to be regretted that the writers of these books are not more careful in their use of technical language. Statements intended for beginners and lay readers should be first of all clear and precise. To illustrate, in the book before us the terms power and energy are used as entirely synonymous. Now, in order to make even the most elementary calculations relating to the size of a motor and the work it is to do, it is necessary to distinguish between the entities that these terms represent. It is well to remember that ideas about engineering matters must be definite if they are to serve as a guide to action.

NOTES AND PROBLEMS on the Adjustment and Use of Engineering Instruments, including Forms for Field Notes for the use of Students in Topographic Engineering.—By Leonard S. Smith, Assoc. M. Am. Soc. C. E., Assistant Professor of Topographic and Geodetic Engineering in the University of Wisconsin: The University Co-operative Association, Madison, Wis. 4½ x 6½ ins.; leather, pocket-book form; pp. 52. 75 cts.

This little book is the outgrowth of the series of mineograph instruction papers used by Prof. Smith for several years past in the instruction of the students in field work at the University of Wisconsin. The five chapters which the book contains are devoted respectively to the use of chain and tape, use of the compass, use of the level, use of the transit and office work in connection with surveys, and finally topographic surveying. Nearly the entire space of each chapter is devoted to the statement of problems or exercises, of which there are 55 in all. In each the task to be performed is definitely stated, and the student is given such instructions, and only such, as are necessary to enable him to perform the work with the knowledge already gained in the class room.

As the problems refer frequently to the special locations where the work is to be done, the book is hardly available for class use at other institutions. Those engaged in teaching surveying, however, cannot fail to find valuable hints in it as to methods of carrying on their work.

ANNUAIRE DE L'OBSERVATOIRE MUNICIPAL DE PARIS, DIT OBSERVATOIRE DE MONTSOURIS. Pour l'anne 1900, Analyse et Travaux de 189[illegible] Meteorologie, Chimie, Micrographie, applications a l'hygiene. Paris: Gauthier-Villars, 55 Quai des Grands Augustins. Paper; 6 x 3¾ ins.; pp. 578; 60 cts.

This annual has been published since 1872, and records the work of the departments of physics and meteorology of the city of Paris, and the neighborhood. The chemical reports cover the variations in the composition of air in the different quarters of Paris; the variation in the chemical components of water distributed for public and private service; the chemical characteristics of city sewage and that of the outfall into the river; the underground water of Paris, as found in wells; the characteristics of the water of the Seine throughout its whole length and atmospheric conditions. This department also reports on the methods of filtration and purification of water proposed in Paris. The micrographic service reports upon the bacteria of the air, soil and water, and especially upon the number and nature of organic dust particles held in free and in confined air spaces; the first covering the wide streets and parks, the latter the air in houses, schools, sewers, etc. This annual also contains much interesting detailed information about Paris and its immediate neighborhood.

SCHOOL SANITATION AND DECORATION.—A Practical Study of Health and Beauty in their Relations to the Public Schools. By Severage Burrage, B. S., Professor of Sanitary Engineering in Purdue University, and Henry Turner Bailey, State Supervisor of Drawing, Massachusetts. Boston: D. C. Heath & Co. Cloth; 6 x 9 ins.; pp. XVI., 191; 52 plates and 28 figures in the text. Price, $1.50.

One's first impression of this volume is that school decoration is made more prominent than school sanitation, but this is due to the numerous well-chosen and beautiful illustrations which cannot fail to attract the eye of any one who gives the book even a casual examination. Both divisions of the volume are treated in a most admirable manner. Sanitation is made to include nearly everything affecting the health of pupils, from the site, design and construction of the building to its fittings, furnishings, heating, ventilation, lighting and the medical inspection of school children. Likewise decoration is used in a very broad sense to include all the artistic features of the building, from its general design, the material, finish and colors of the interior to the decorations in a more limited sense, and even to questions of artistic taste in the rendering of exercises involving writing, drawing and other work of the hand and eye. Gymnastics and manual training are not discussed, but attention is called to the advantages of having baths connected with the public schools, especially in sections where no proper facilities for bathing are to be found in the homes of some of the pupils.

One of the best things about the book is that its field of usefulness is not limited to schools, but may be extended into all homes, especially homes where there are children. This is particularly true of the decorative, or more properly the artistic features of the book, since it is probable that home sanitation is now receiving far more wise attention than home decoration, boards of health ministering in one case, but there being no corresponding oversight in the other.

THE PREVENTION OF FACTORY ACCIDENTS.—Being an account of manufacturing industry and accident, and a practical guide to the law on the safe-guarding, safe-working and safe-construction of factory machinery, plant and premises. With 20 tables and 125 illustrations. By John Calder, Whitworth Scholar, sometime Her Majesty's Inspector of Factories for the North of Scotland. London and New York: Longmans, Green & Co. Cloth; 7¼ x 4¾ ins.; pp. 325; illustrated. $2.50.

While this work is based upon English practice and English law, very much of its contents are applicable to our own country, in all that relates to the safe construction and operation of machinery. As showing the necessity for legislation and forced attention to the better safety of workmen, the author notes that in 1898, throughout the United Kingdom, 3,897 persons were killed and 79,727 were more or less injured in the peaceful pursuit of industry. This is a casualty list considerably exceeding that of some famous campaigns. The author, by means of tabular returns, goes into the details of these factory accidents, and follows this with the legislation enacted; the employer's liability for accident, and the Workmen's Compensation Act of 1897. This act gives to workmen, or in case of death to their dependents, definite compensation for all personal injuries by accident arising out of, or in course of specified employments. The act specifies the amounts to be paid—if claim is made within six months of the accident. The more valuable part of the work to American readers relates to the causes of factory accidents and to the method of safe-guarding engines, mill-gearing, hoists and lifting-tackle, dangerous machinery, etc. The author describes and illustrates these methods and gives the reasons for their adoption. Fire-resisting construction and fire-escapes; first aid to the injured, and the full text of the English law on accident and safety in factories, conclude the work, which is a valuable contribution to the literature of this important subject.